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CONTROL OF ATOMIC ENERGY

THE second report of the Atomic Energy Commission to the Security Council which was adopted by the Commission on September 11 with only the U.S.S.R. representative voting against it, although the Polish representative abstained, outlines specific proposals dealing with the functions and powers of an international agency for the control of atomic energy. The Commission did not consider that the Soviet Union's proposals of June 11 provided an adequate basis for developing specific proposals for an effective system of international control of atomic energy, and discussions have not led to a reconciliation of the views of the Soviet Union with those of the majority of the Commission on major points of principle. The proposals of this second report are, in fact, based on three principles which were vigorously contested by the representative of the U.S.S.R. These principles are, first, that decisions concerning the production and use of atomic energy should not be left in the hands of nations; secondly, policies concerning the production and use of atomic energy which substantially affect world security should be governed by principles established in the treaty or convention which the agency would be required to carry out; and thirdly, nations must undertake by convention to grant to the agency rights of inspection of any part of their territory, subject to appropriate procedural requirements and limitations.

The proposals of this second report provide for production quotas based on principles and policies specified by convention; ownership by the agency of nuclear fuel and source material; ownership, management and operation by the agency of dangerous facilities; licensing by the agency of non-dangerous facilities to be operated by nations; and inspection by the agency to detect clandestine activities. The specific proposals of this report are believed by the Commission to provide the essential basis for establishing an effective system of control to ensure the use of atomic energy only for peaceful purposes, and to protect States which comply with it against the hazards of violations and evasions. Furthermore, the Commission considers that such questions as the organisation and administration of the agency, the geographical location of dangerous activities and 'stock-piling', prohibitions and enforcements, and the stages of transition to a system of international control, can only be discussed effectively within the framework of conclusions regarding the functions and powers of the international agency.

In arriving at these conclusions, the Commission believes that the establishment of security is the paramount requirement, and the system of control is designed to give the international agency the means of preventing preparation for atomic warfare, as well as to diminish the possibility of one nation or group of nations achieving potential supremacy in the field of atomic energy, to give warning to complying States of any breach of the treaty and to dispel suspicions and false accusations. In choosing between alternative policies, the elimination of national

rivalries in the production, distribution and accumulation of nuclear fuels and the determination of overall production-rates are regarded as of outstanding importance to security. At present the science and technique of the production of nuclear fuel are far in advance of its use for peaceful purposes; nuclear fuels can be produced in quantities which greatly exceed their present possible uses in medicine, research and industry. In stressing this, the report emphasizes that if the right to decide on the number and size of production facilities and on the size of the stocks of source material and nuclear fuel situated on their territory be left to nations, the control measures recommended in the first report of the Commission would not, if applied alone, eliminate the possibility of one nation or group of nations achieving potential, or through seizure, actual, military supremacy.

For this reason the right to take these decisions cannot be left in the hands of individual nations; and accordingly, in this second report, the Commission would charge the international agency with the further duties of implementing the terms of the treaty or convention in respect to the production, distribution and storage of nuclear fuels and the distribution and utilization of dangerous facilities depending on nuclear fuels, as well as supervising mining quotas and the transfer and processing of source material. It is not recommended, however, that the agency should define the policy to be pursued in the production and use of atomic energy. The principles governing this policy should be established by international agreement, and it would be the duty and responsibility of the agency to implement such an agreement. The production of nuclear fuel in a form suitable for ready conversion to weapon use would be kept by the agency at the minimum required for efficient operating procedures necessitated by actual beneficial uses, including research and development. The agency would also be charged with the duty of carrying out the terms of the treaty or convention concerned with the type and location of reactors which fall within the category of dangerous facilities; and when the technique of the industrial utilization of atomic power has been sufficiently developed, the international agency, within the limit imposed by security, should make that power available on a fair and equitable basis to any nation which may require it.

In regard to research and development, while the agency should have the power to conduct such work, and must have full scientific knowledge of all matters relating to atomic energy, including all innovations as they occur, it is not proposed that private or national research or development work should cease. Such national activities would be limited in scope only in so far as is necessary for reasons of security. Nations or individuals would be forbidden to use nuclear fuel for the manufacture of any atomic weapon, or to use dangerous quantities of nuclear fuel. Since the first report was issued, further study has established the necessity for international control and allocation of the quantities and locations of uranium and thorium which are to be separated, the time and place of the further processing and purification of source materials, and the size, use and disposition of working stocks and stocks in transit. Without such comprehensive international control of the flow of source materials, from the first point where they are capable of being diverted, there would always be a serious risk of the diversion of source material.

The basic policies and provisions governing the exercise of this international control and direction must be specified in the treaty or convention; ownership of source-material, from the time it is removed from its natural deposit, or from the time other important constituents have been extracted, should be vested in the agency, which would be authorized to lease these materials for authorized uses. The exercise of the right which the international agency must possess, of determining on the spot whether a nation is conducting clandestine preparations for atomic warfare, would be subject to various procedures designed to guarantee nations and individuals against abuse on the part of the agency. These procedures will require consideration from a juridical point of view so that they may be defined in legal terms capable of juridical interpretation.

The rejection by the Soviet Union of the very principles on which these proposals are based, including as they do the prohibition of atomic weapons, makes it difficult to see what further proposals can be advanced with any real hope of unanimous agreement. It is not that there appears to be any ideological obstacle to preclude such agreement: apart from the International Control Commission proposed by the U.S.S.R. last June, so long ago as February 15, 1928, the U.S.S.R. delegation to the League of Nations proposed in a draft Disarmament Convention the adoption of a comprehensive scheme of international inspection. It seems rather that the U.S.S.R. refuses to recognize the logic and inevitability of the conclusions reached by other members of the Commission, and insists on imputing bad faith to all those who do not accept its own views.

Admittedly the atomic bomb put the United States in a powerful position in the military sense, and if competition in atomic weapons should prove unavoidable the United States would have a considerable start which it could almost certainly retain without difficulty. That its desire is otherwise could scarcely be made clearer, and it may well be questioned whether any country could have shown a more striking example of disinterested good faith in the peaceful aspirations of the common man. All atomic energy matters have already been placed by the U.S. Government under civilian control to facilitate the application of atomic energy to peaceful and beneficial purposes. Within its own territory also, all uranium and thorium ores, even those which contain as little as one twentieth of one per cent, have already been placed under the strict control of the American Atomic Energy Commission; and even apart from the threats and accusations of the U.S.S.R., the United States can scarcely be blamed for declining to destroy its stocks of materials before an international authority has been set up with the powers and resources to exercise effective control.

While it may be doubtful whether the U.S.S.R. would accept the point that a convention outlawing the atomic bomb could come into force only when satisfactory controls have been established, the suggestion has not yet been rejected by Mr. Gromyko. Moreover, against the slight gain that the international inspectorate to which the U.S.S.R. has agreed is to be answerable only to the Control Commission, has to be set the unequivocable rejection of the functions of licensing, management and supervision of the dangerous undertakings. Even minor powers of control by the Commission remain subject to the veto in the Security Council, and national acceptance of any recommendations for the carrying out of international rules is to be entirely optional. The questions of secrecy and of the exchange of information are scarcely mentioned in the second report, although their importance is emphasized in the Russian proposals. Without the inclusion of all these safeguards against national misuse of atomic power on which there is widespread agreement outside the U.S.S.R., no form of inspection could be effective.

It is still necessary to continue to explore the possibility of agreement, even though it be with diminishing hopes. The two primary questions that are now emerging, however, are whether at the present time it would not be wiser to postpone consideration of the control of large-scale power production and forgo the use of atomic power until the world is better prepared for it; and whether the development of an atomic energy authority among those nations which are prepared to accept the essential limitations of sovereignty should proceed. The first question has been pressed by two of the scientific workers who worked in the Oak Ridge gaseous diffusion plant, Mr. Cuthbert Daniel and Mr. A. M. Squires, who have suggested that for the present not even the atomic development authority should either mine or process fissionable materials or operate reaction piles which would yield significant quantities of nuclear fuel, and that production of weapons and further weapon research should be stopped. With the setting up of international inspection, the authority would take over all existing plans and stocks together with the 'secret', and it would also arrange for an approved allotment throughout the world of all the fissionable materials required for other purposes, but would destroy all surpluses and dismantle the plants.

Such a plan bids high for Russian agreement, and might secure it; but the vital question here is not whether the advantages to be gained from the industrial use of atomic power are worth the risks of the bomb which they incur. It is not simply a question of whether it is worth taking an avoidable risk for the sake of what might be gained at the power stations in the next twenty years. The question is rather, is the risk avoidable? To put it bluntly, could the United Nations trust Russian adherence to such an undertaking in the absence of such an inspection system as is proposed by the Atomic Energy Commission itself?

If we cannot give ourselves a satisfactory answer to that question of good faith—and recent developments make that increasingly probable—we are left with the security issue paramount, and the question becomes whether we should go forward without the U.S.S.R. with the development of an atomic energy authority. There can be no doubt as to the dangers and difficulties of such a course, but equally we should not overlook the value of a practical demonstration of the possibility of an international system even within a limited field. If the United States, Great Britain and a number of other like-minded States could demonstrate to the world that the essential sacrifices of national sovereignty were, in fact, being made, and that the system was working satisfactorily, the all-important first step would have been taken and nations at present inclined to stand aloof might come in. But participation now or at a future date presupposes just that goodwill, that confidence and mutual respect which the U.S.S.R. is disposed to deny to those who are unwilling to be over-ruled by her authority. Whether even in the field of science those relations of trust and understanding can be established, in the face of restrictions on movement and such restraints on communication of scientific and technical information as those of the new Russian law on disclosure of State secrets, may be doubtful. It seems clear, however, that in this field of atomic energy, as in wider fields of science, the scientific worker can only seek to move forward on the line that the discipline and tradition of science have taught, avoiding so far as possible all that could exacerbate feelings or confuse the issue, testing each hypothesis and trying out the most promising in a limited field if necessary, and extending the experiment as the results indicate and opportunity offers.

THE DEVELOPMENT OF BRITISH CHEMISTRY

The Chemical Society, 1841–1941

A Historical Review. By Tom Sidney Moore and James Charles Philip. Pp. 236+10 plates. (London: Chemical Society, 1947.) 12*s*. 6*d*.

British Chemists

Edited by Alexander Findlay and William Hobson Mills. Pp. 432+16 plates. (London: Chemical Society, 1947.) 18*s*.

FOUNDED in 1841, the Chemical Society was the first nation-wide organisation concerned exclusively with "the advancement of chemistry and those branches of science immediately concerned with it". It led the way to the foundation of similar societies in France (1857), Germany (1867), and the United States (1876). Among permanent records of the recent centenary celebrations, the Society has issued these two appropriate volumes. They abound in material of abiding interest to all lovers of chemistry, and are truly worthy of the historic occasion.

The first volume traces in detail the foundation and growth of the Society. It is a story of modest beginnings, of growing pains, and of many later vicissitudes; but the curve of progress ascends steadily with the passage of time. Of willing and devoted members and officers there has never been a lack in this Society.

The tasks have passed from hand to hand, from generation to generation; but they have always been fulfilled.

As we read, the story grows into one of expanding activities and increasing complexities of organisation and administration, brought about by the astonishingly rapid development of chemistry and of the chemical profession in Great Britain. When one considers the handicaps under which the Society has laboured, its accomplishments appear all the more remarkable. The greatest handicap of all has been for many years the lack of housing accommodation. "The Meeting Room . . . is filled to suffocation at discussions and can seldom be used for lectures . . . after a century of public-spirited activity the Society is housed in premises which in no single respect are even tolerably adequate for its nationally important work." The Society provides the main channel in Britain for the publication of research in pure chemistry, and houses a national chemical library; yet, to take one problem alone, it is called upon to operate in these confined quarters "a library of 44,000 volumes growing at the rate of about 1,000 volumes a year, to the use of which 15,000 individuals are entitled".

The narrative, which is embellished with ten illustrations of much historic value, throws light upon the foundation of other organisations of chemical interest, such as the Institute of Chemistry, the Society of Chemical Industry, and the Association of British Chemical Manufacturers. To a large extent these and still other organisations may be regarded as offshoots of the Chemical Society, and it is a satisfactory feature that a growing co-operation has taken place in recent years between the numerous British societies owing an ultimate allegiance to chemistry. It is to be hoped that this tendency, which means so much for British chemistry, may lead ultimately to the realization of Pope's ideal of a 'Chemistry House' to accommodate all the chemical organisations, thereby releasing the Chemical Society from its cramped quarters in Burlington House, London.

Although the first of the volumes under notice deals primarily with the organisation and growth of the Society, it throws many interesting sidelights upon past presidents and others who have been closely concerned with that organisation and growth. It is illuminating, for example, to find Liebig writing of England as "the country which I love like my own Fatherland"; and to discover Victor Meyer sitting between Roscoe and Hugo Müller at the jubilee dinner of the Society (1891) and talking of "Kekulé, as, buried in thought, he rode home on the top of an omnibus through the streets of this great metropolis, after spending an inspiring evening with my neighbour on my left, his friend Dr. Hugo Müller". Those were truly days of internationalism in chemistry.

In these pages, too, we encounter the doughty H. E. Armstrong, the 'grand old man' of British chemistry; Vernon Harcourt, whose "long sentences were as precious to him as to Henry James; but he swayed them with equal skill and we would sigh with relief when the soothing and beautifully modulated voice emerged successfully from a seemingly hopeless tangle"; Tilden, with "that shade of dignity which has now become old-fashioned but remains precious"; Philip, the range and quality of whose personal services is probably the greatest in the history of the Society; Meldola, who traced his descent through sixteen generations back to Israel Meldola, born at Toledo in 1282; Ramsay, P. F. Frankland, W. H. Perkin, jun., Pope, Morgan, Greenaway, the courtly and upright G. G. Henderson, and many another. Here is a richly variegated human tapestry.

The main theme of the first volume is the development of the Chemical Society. Happily, however, as just indicated, the account includes also numerous short personal sketches of eminent British chemists who have served the Society in their day and generation. This is a particularly valuable feature to the humanist in chemistry; for the second volume, which is complementary in scope, deals solely with the personalities and researches of a strictly limited number of British chemists of this period. Naturally, in a volume of this size, it is impracticable to give full-length studies of more than a select few of the outstanding figures. These range in chronological order from Crookes, who was a boy of nine when the Society was founded, to Barger, born in 1878.

Here we find worthy biographical sketches of sixteen British masters who have died since the outbreak of the First World War. Some of these memoirs have been specially contributed by writers with first-hand knowledge; others are reprinted or adapted from existing memoirs. The volume, which has been skilfully edited, contains an account of the life and work of each subject, together with a portrait. It fills a gap in biographical chemistry which has persisted for too long; for although the Chemical Society has published several volumes of memorial lectures of much dignity and charm, dealing with distinguished foreign chemists, it has been unduly modest in this respect about its own members. Now that the ice has been so admirably broken, the hope may be entertained that future volumes of a similar kind will be forthcoming in due season. These might perhaps to some extent be retrospective, so as to include not only British masters of the future, but also some more of the chemical past masters of the British Commonwealth of Nations—such as Purdie, in Scotland, Orme Masson and H. G. Smith, in Australia, and P. C. Ráy, in India—for whom space could not be found in this inauguratory volume.

In conclusion, it is pleasing to note that the cost of these two volumes has been generously defrayed by the printers, Messrs. Richard Clay and Company, Ltd., who have done so much yeoman work for the Society, as a contribution to the centenary fund. Together, the two volumes form a contribution of such high interest and value that they will inevitably find a place upon the bookshelves of all who have a lively interest in chemistry.

JOHN READ

VEGETABLES OF HONG KONG

Vegetable Cultivation in Hong Kong

By G. A. C. Herklots. Pp. iv+208. (Hong Kong: South China Morning Post, Ltd., 1947.) 12 dollars.

BOOKS on gardening are many and varied, but few volumes can have made a more dramatic entry to a localized horticultural community. Born during the incipient siege of Hong Kong and nourished during a forty-three months 'sojourn' in the Stanley Civilian Internment Camp, the book holds the attention of even a Western reader. It must have a far greater significance in the region for which it is particularly written. The volume describes about a hundred kinds of vegetables, giving cultural details, discussing varieties, recipes and food values. Chinese names and ideographs appear in the text, and most species are illustrated by very clear but artistic line

drawings. Woven through these foundation strands, however, is a very modern exposition of horticultural science. This is, of course, particularly adapted to Chinese conditions; but is a graceful blend of simple, age-old methods with modern scientific achievement. One learns how to compost organic matter with human urine and also the use of D.D.T. for pest control. 'Canton mud' settling from ponds where fish are fed on human excrement still provides a source of garden fertility, and yet weeds are now controlled by 2 : 4 dichloro-phenoxyacetic acid.

Horticulture in Hong Kong brings its own special problems. Seeds must, in general, be kept dry until planted, being packed in lead envelopes, and even stored in a desiccator. Periods of dormancy and of seed life are very short; parsnips and rhubarb provide good examples, while *Hippeastrum* seeds should be sown within a day or two of dehiscence from the capsule. New Zealand spinach seeds, on the other hand, germinate more vigorously after a year's storage. Hong Kong soils vary from porous lateric sand to an impermeable clay, but all are poor in major plant nutrients and most are too acid for good growth of vegetables. Several pages are accordingly devoted to the improvement of the physical and chemical nature of the soil. Temperature limits the growth of some plants, as the English cabbage, to the winter in Hong Kong, but tropical warmth from May until September permits the growth of many plants from the torrid zone. Periods of high humidity in March and April provide good conditions for the spread of fungal diseases in those months. The relatively short day makes it impossible to grow European varieties of onions for bulb formation. Seed potatoes from England do not grow well in Hong Kong, but several short-day potatoes from the Empire collection at Cambridge have been flown there and are now under trial. Other adaptations to special conditions are discussed in this book.

Many English friends of Dr. Herklots will value this publication, not only for its scientific and horticultural worth, but also as marking a vigorous return from the trials of internment. It seems possible to read between the lines, to imagine the difficulties at Stanley camp, and to admire the persistence which produced this most useful book. It would have been a credit to a similar study made in freedom.

JOHN GRAINGER

AMERICAN METHODS AND PRACTICE IN AIR SURVEY

Manual of Photogrammetry

Edited by P. G. McCurdy, L. A. Woodward, J. I. Davidson, R. M. Wilson and R. E. Ask. Pp. ix+819. (New York, Chicago and London: Sir Isaac Pitman and Sons, Ltd., 1944.) 45*s*. net.

THIS manual has been produced by the American Society of Photogrammetry, some sections having been previously published in *Photogrammetric Engineering*, the journal of the Society. The Society is a very active one, and its journal regularly provides valuable technical information. Its membership extends overseas, including some from Great Britain.

The manual is composed of contributions by some thirty eminent members, together with sections from official and commercial sources. It has been edited by a small committee and presents an up-to-date picture of aerial photogrammetry with reference to American practice.

The range of subject-matter is wide: from the principles of surveying, optics, photography, perspective, and stereoscopy, to the basis and practical application of graphical, analytical and instrumental methods of mapping from air photographs. The chapters in themselves are self-contained.

One of note is that on mapping from obliques, which is dealt with in some detail. Practice in Canada, where considerable areas have been covered by obliques for reconnaissance mapping, is described, as is that developed by the American Geographical Society, with particular reference to exploratory surveys. Most important, however, is the section on trimetrogon mapping, in which three wide-angle cameras are used—one vertical and two lateral high-obliques—so that a lateral strip is covered from horizon to horizon by each set of exposures. By use of primary trigonometrical control, or independent astro-fixes, a rapid and effective method is available of reconnaissance mapping at scales of 1/250,000 or 1/500,000. Many hundreds of thousands of square miles were mapped by the U.S. Army Air Forces during the recent War in connexion with the charting of air routes over undeveloped country.

Another important chapter is that on radial line plotting, where, in addition to the usual graphical method, descriptions are given of its 'mechanization', by slotted templates or by mechanical radial arms.

The chapter on American survey cameras, mostly of Fairchild manufacture, is in the nature of a catalogue. No foreign types are described.

The manual is a mine of information on practical detail, evolved as a result of lengthy experience in the methods described; but it suffers inevitably from its preparation by a large number of contributors. Some aspects are omitted altogether, others sketchily treated from a scientific point of view, while there is some overlapping between the chapters, due to different authorship and separate publication.

It can by no means be considered a text-book of the subject, since no attempt is made to present a balanced and logically developed treatment. It is surprising, for example, to find that there is no reference to precise three-dimensional instruments such as those of Wild, Zeiss and Poivilliers, or of British designs, since instruments of this class are now recognized as having important applications in air survey. Also the title should be more properly "Manual of Aerial Photogrammetry", since there is no reference to ground photogrammetry. The edition is, however, a provisional one, so it is to be expected that some of these anomalies will be omitted in subsequent editions.

The final chapter on nomenclature and definitions is particularly welcome, and although some of the terms are at variance with British practice, it is to be hoped that it will not be impossible in the future to standardize.

The manual will prove a valuable reference work to air surveyors so long as it is recognized that it refers to American methods and instruments only. There is little critical comparison between the various American instruments and methods, some of which have been described by those commercially interested in them. Neither is there any description of, or comparison with, methods and instruments used extensively outside the United States, in the British Empire and elsewhere.

C. A. HART

OPERATIONAL RESEARCH IN WAR AND PEACE

A DISCUSSION on operational research in war and peace was held by the Division of the Social and International Relations of Science of the British Association, during the Dundee meeting of the Association. The chair was taken by Dr. C. H. Desch and the discussion opened by Sir Robert Watson-Watt. Other speakers included Dr. O. H. Wansbrough-Jones, Prof. S. Zuckerman, Prof. W. C. Wilson, Prof. F. A. E. Crew, Mr. L. Moss and Prof. J. D. Bernal.

Sir Robert Watson-Watt said he believed that responsibility for the term 'operational research' rested with himself. He had no recollection of any positive definition, which did not emerge until late in the work, although it contained something of "doing arithmetic for Air Staff", market and consumer research, and the less naively offensive elements of motion study. Neither did he recognize the description of operational research by the president of the British Association, Sir Henry Dale, as that "which estimated destructive effects and planned destructive policy". If terms of reference were needed, he would suggest these, for industry as well as in war:

"To examine quantitatively whether the user organisation is getting from the operation of its equipment the best attainable contribution to its overall objective, what are the predominant factors governing the results attained, what changes in equipment or method can be reasonably expected to improve these results at a minimal cost in effort and time, and the degree to which variations in the tactical objectives are likely to contribute to a more economical and timely attainment of the overall strategic objective."

Operational research, Sir Robert proceeded, is beginning to look very like real scientific management, and he believes that it is an important contribution to the still unsolved problem of the relationship between the administrator and the expert. The essence of that licensed busybody, the operational researcher, is that he has learnt about things and about people, that he "lisps in numbers, for the numbers come", and that he is believed by the individual user of technical equipment because he and his like have been shown capable of ensuring great improvements in the performance of the equipment and in the comfort, security and self-fulfilment of the user. In war, the pioneer practice in the R.A.F. might be described as having been centrifugal, certainly as highly devolutionary, and the naval counterpart was by contrast highly centralized. In peace, Sir Henry Dale had a right to ask whether "we can accept as directly obvious the suggestion that Operational Research . . . would qualify for guidance in the immeasurably more complicated and fundamentally different problems of reconstruction". It would be disastrous if this legitimate query were misread and misapplied as a positive statement of rejection. Sir Robert doubted whether the peace ensemble is, in fact, more complex than the war ensemble, nor could he perceive any fundamental difference between the problems within a peace-time industry and those on one side of the gulf of war. The argument, he considered, was "desperately important" and he said he meant every syllable and stress of those words.

In conclusion, it was with profound regret that he had heard Sir Henry Dale speak of the "conscription of science". All that was asked by those who believed in the present application of operational research, and felt that "the rocks might crumble beneath the ivory city", was that they "be given the academic freedom of operational research to measure the facts, the dangers and the towering possibilities".

Dr. O. H. Wansbrough-Jones, speaking of Army applications, stated that the method should have improved on that recommended by Newton for navigational technique by the introduction of better statistical and other scientific tools; and on current methods of administrative planning in the Army by giving greater freedom both in opportunities of direct observation and of freedom from daily routine. Also, although successes might rightly be claimed by those who did the work, their scientific training and objective approach would have been insufficient if there had not been a readiness, especially at high levels, to receive, absorb and encourage these scientific men and to heed their results; if there had not been a few outstanding men of science to lead the work, as well as a sufficient body with a good knowledge of the ways, tasks, and difficulties of the Army; and, pervading it all, the intense stimulus of national need. Unless each condition was met, at least in part, this type of work would not be useful.

Home sections were formed during the War to study tank gunnery, field artillery and infantry weapons, and the process culminated in the provision of a further six sections to work in theatres of operations. Up to the end of 1945, some 365 scientific workers were employed in operational research on behalf of the army, the maximum number employed at any one time being about 174. Up to date, they had produced some 380 reports of varying importance roughly equivalent in size to the average scientific paper, and nearly 600 memoranda of smaller importance, besides dealing with a very large number of day-to-day queries. Those at home had worked under the Ministry of Supply, and the overseas sections under indirect War Office control. The present scientific force is very much reduced, and the division between the Ministry of Supply and the War Office still remains, but the relationship is very close and likely to become closer.

Taking two overseas sections as examples, that with 21st Army Group had a maximum strength of twelve. It was in the theatre of operations from D-Day until July 1945, and produced some forty reports covering a variety of subjects most of which had been suggested by the investigators themselves. Those first selected, after a few weeks of initial study, were the location of enemy mortars, the distribution of hits and penetrations in our own and the enemy's tank casualties, the performance and best method of use of the PIAT, the problem of dust on roads and airstrips, and the examination of mud. Of these, that on dust was taken over by the Air Force, that on mud proved too valuable, and the PIAT work was mainly technical; but the mortar location and tank casualty work was completed with good results. The report on the first was the factual basis of the counter-mortar organisation later set up with 21st Army Group: that on the second provided accurate data on how armour should be distributed on tanks fighting in close country. Work was also continued on the two basic problems of air and artillery bombardment, and events led the operational researchers back to them. Among the results was the first objective assessment of the effects achieved by a given weight of bombing in support of ground troops.

The corresponding section with the 14th Army in Burma determined maintenance tonnages and man-power wastage. In the event, the application of these two studies to the planned assault on Malaya and Singapore remained untested. As to the need in such work for highly trained scientific workers, Dr. Wansbrough-Jones suggested that, although operational research probably did not demand such training, it was greatly helped by scientific training. "It is much more", he stated, "than the straightforward collection of facts and the writing of histories; it must continually seek out new sources of information, especially the least obvious, and by sound reasoning from the facts, provide a new understanding of its particular problem." In peace the emphasis falls naturally on training and administration, and it is hoped to study, in particular, the adequacy of the existing motive of Army service, means for increasing its value, and the effectiveness of substitute motives such as group or individual rewards, the acquisition of knowledge and skills, and the use made of synthetic trainers of various types.

Dr. Wansbrough-Jones believes that for some young scientific men, those really interested in the social applications of science, diversion for a time to operational research, but not for too long, would be not only justifiable but desirable. With adequate safeguards, and good career control, it would be an advantage to many to work for a year or so, say in their late twenties, for a Government department; to leave industrial laboratories to work on the scientific man-power sides of their industries, and defence laboratories to work with the Services. Army plans for the last are being put into force.

Prof. S. Zuckerman distinguished between operational research at the technical, tactical and strategic levels. At the first level was an investigation of the manner in which bombs cause casualties, and it was at this level that the better part of the scientific man-power engaged with the Fighting Services during the War was employed. Operational research into different kinds of tactics and methods of organisation consumed the bulk of the remaining effort. One example was the relationship between different types of formation-flying and accuracy of bombing. Scientific men, with their understanding of the techniques involved, appreciation of the tactical problems to be overcome, and emphasis on objectivity and statistical method, can arrive at solutions about tactics which could have been derived only accidentally by other methods. Scientific intervention at the level where major strategic policy is determined was slight—although it would have been impossible for the Ministries of Food and Home Security, for example, to take reasonable decisions on policy without the constant help of expert knowledge, fortified in one case by nutritional surveys and in the other by a large organisation working experimentally and in the field. On the military plane, however, most major operational policy was determined without recourse to scientific advice, and examples of scientific intervention are thus few. Lord Cherwell, as Paymaster-General and scientific adviser to the Prime Minister, was no doubt able to bring scientific method to bear on decisions affecting major policy. In addition, two specific examples were quoted. In the anti-U-boat campaign, scientific analysis not only helped to determine the convoy system, but also assisted in showing the value of diverting four-engined bomber aircraft to U-boat patrols. The second concerned the strategic policy underlying the employment of heavy bombers against the enemy. Objective and quantitative analysis showed that the bomber offensive against German industrial cities was not depressing the level of German production to the extent hoped for, but that attacks against communications would have a far-reaching and immediate effect. Revision of strategic policy in the spring of 1944 was based on this objective appreciation, which was confirmed by subsequent examination in Germany.

What was true about the value of scientific method during the War is no less true to-day, Prof. Zuckerman proceeded. War is not a state of unfettered individual enterprise, any more than unfettered individual enterprise could be the characteristic of the present economic and political state of Britain or Western Europe as a whole. The Government has added to the normal function of administration executive duties which make it necessary either that officials should lean more and more upon scientific advice or become more and more scientific themselves. Cabinet planning bodies such as that presided over by Sir Guy Plowden, and the Advisory Council on Scientific Policy presided over by Sir Henry Tizard, may be regarded as operational research sections established at a strategic level in the economic field. As the situation develops, the function of such different bodies may find a common meeting-ground for the exposition of the major economic, scientific and administrative problems which have to be taken into consideration in a fruitful peace-time strategy.

Prof. W. C. Wilson described the work of No. 1 Medical Research Section in the Middle East between May 1942 and April 1943. Its mandate covered all matters concerning the welfare of fighting men in a very large territory with several distinct and varied climates. The reports of Dr. A. L. Chute, a Canadian physician and physiologist, gave extensive factual data on wounds, evacuation of wounded, fatigue, effects of stress, hours of sleep, food, appetite, cooking and other aspects of tank fighting. Dr. E. T. C. Spooner, a Cambridge bacteriologist, undertook a general survey of Middle East conditions, and studied the typhus situation in Egypt, desert sores, and the outbreak of infective hepatitis of late 1942. Prof. Wilson's own work was on the problems of burns and 'wound shock'. Points which stood out in retrospect were the value of a section composed of independent, full-time and fully mobile observers; and the conclusion that minority opinions should not be ignored, even when counter to expected results. The shortage of trained medical investigators had proved a handicap, and Prof. Wilson was not optimistic that it could be easily or quickly remedied. But if the latent forces of interest and idealism in the medical profession could be mobilized, they might provide a research weapon of immense power in new fields such as social medicine.

Prof. F. A. E. Crew discerned two phases in the application of scientific research in a protracted war: the first in which the production of machines and materialities were the essential preoccupation, and the second in which these were gradually overtopped by problems of the health, morale and efficiency of men. It had been expected that the Army Council would refer to the Medical Research Council any problem of urgency and military importance which fell into the sphere of the biological sciences; but this arrangement did not work, and Sir Edward Mellanby had ultimately created a field investigational organisation which provided the model, so far as he

knew, for what was later done by the Army itself. Lessons for the future were that the nature, and even the existence, of a problem of quite serious importance could remain unrecognized until investigated by selected and highly trained scientific workers; that mixed teams are required, of compositions determined by the probable nature of the problem; that hopeful investigation depends on willingness on the part of the community to participate actively; that results, however potentially valuable, can remain disregarded until thoroughly appreciated at the topmost levels; and that for rapid solutions, simultaneous investigation in different circumstances by different teams is a very great advantage. The only danger is that, with the return of peace, the Medical Research Council might find it necessary to withdraw from social biology.

Mr. Louis Moss, director of the Government Social Survey, referred to the need for studies of both the social and industrial conditions of particular jobs, as well as of the attitudes of potential recruits, if labour were to be induced rather than compelled to particular industries.

Prof. J. D. Bernal, as the last speaker, was handicapped by the length of discussion which had already taken place, and what follows is based on the written contribution which he had intended to make. The same needs, he contended, that led to the appearance of operational research in war should now lead to the conversion of that experience to peaceful uses, since the gap between imports and exports and the impossibility of Britain feeding itself are at least as serious and immediate as any war situation. 'Operation Production' should be considered with the same urgency and common purpose as 'Operation Overlord'. The technique of operational research could be made available to find out what has to be done, to check the success of the operation and modify its conduct. It is essential that the country's very limited resources in trained man-power in engineering and science should be used in the most effective way with a scientifically determined system of priorities, weighing not only present resources, but also those which could be increased, often by very large factors, by the application of high-pressure research and development. Only a combination of economists, engineers and scientists could achieve this; but they must operate on the highest planning authority in the country. The most obvious priorities are coal, steel, building and agriculture, but others such as transport, distribution and the utilization of chemical wastes may prove equally important. Prof. Blackett's general principle of operational research should be used, to do those things which combine the greatest need with the most rapid possibility of achievement.

All these are in the nature of economic planning, but physical research is required wherever materials and techniques have to be transferred from their present use to some new one. Lively and effective research would also be necessary on the workshop and farm level, and all the ingenuity in the country would be needed to solve the thousand small problems that would arise. Thousands of scientific workers and engineers are being used in a wasteful manner or for purposes of secondary importance—a very large number in industry and probably as many in Service research. Operational research is needed to find the best distribution and to check redistribution. It would be tragic, he concluded, if this one organisational development of the War were not given the chance to show its capacity in the peace.

THE INSTITUTE OF SEAWEED RESEARCH

"HERE, Scotland has a chance. Eire, Norway, America, Japan, have all, in varying ways, exploited their seaweed resources. We are only at the beginning, and this splendid research station gives us the opportunity not only of making up on these countries, but of surpassing them." So declared the Right Hon. Joseph Westwood, Secretary of State for Scotland, when, on September 19, he officially opened the headquarters of the Scottish Seaweed Research Association—the Institute of Seaweed Research, Inveresk Gate, Musselburgh, Midlothian. Until recently a large mansion house, Inveresk Gate now contains adequate botanical, chemical, engineering and photographic laboratories, engineering workshops, a drawing office, a library, and conference and display rooms, apart from the necessary offices. The Institute stands in eleven acres of ground, and is situated sufficiently near Edinburgh, the University, and the sea to meet the Association's various needs.

The Association was formed in June 1944, and until Inveresk Gate became available the director and staff used the King's Buildings (of the University of Edinburgh) A.R.P. Control Centre as offices, as well as certain of the University's research laboratories and facilities. During the first two years of its life the Association was financed by means of a grant of £25,000 from the Development Fund. Thus was made possible a survey of Scottish seaweed resources and investigations into methods of harvesting, handling and processing these resources. Now, Government has provided over a period of five years a further sum of £90,000, and it is hoped that at least another £10,000 will be forthcoming from industry, and from public-spirited individuals.

Dr. F. N. Woodward is director of the Institute, but at the moment has been seconded to act as director of the United Kingdom Scientific Mission in the British Commonwealth Scientific Office in Washington. The acting director is Major P. Jackson. Under this joint direction the staff of the Institute operates under three divisions: botanical, chemical and engineering. The activities of these divisions may be outlined, as in the director's report, as follows:

(1) *Survey of Scottish seaweed resources.* (*a*) Development of reliable survey methods. (*b*) Quantitative survey of the Scottish coast for littoral, sublittoral and cast brown weeds. (*c*) Study of economic and ecological factors. (*d*) Determination of optimum conditions of growth by controlled culture.

(2) *Harvesting and processing investigations.* (*a*) Development of economic harvesting methods. (*b*) Determination of optimum conditions of drying, grinding and processing.

(3) *New and extended uses of seaweed and seaweed products.* (*a*) Determination of the chemical composition of Scottish seaweeds and its variation with change of species, season, age, environment, etc. (*b*) Determination of the properties and characteristics of the chemical components of seaweed and their derivatives, with the view of finding new and extended uses. (*c*) Development of methods of production of such constituents and their derivatives as are of potential technical value. (*d*) Determination of the value of seaweed as a component of animal feeding-stuffs and as a fertilizer.

Superimposed upon this programme, and as a logical outcome of its partial completion, is the new problem which arose during 1946, that of endeavouring to establish in the Outer Hebrides a ground, dried, rockweed producing unit.

At this stage it may not be out of place to outline briefly the activities of the three Divisions. Acting head of the Botanical Division is Mr. F. T. Walker. He and his assistant algologists have had to solve one of the two main problems facing the Association, namely, whether or not there is enough weed on Scottish coasts at a density sufficient to warrant commercial utilization. Accordingly, a littoral weed survey was commenced in April 1945 and concluded in December 1946. During this time, 4,250 of the 4,630 miles (92 per cent) of practical Scottish coast, exclusive of the Shetlands, were covered and more than 180,000 tons of littoral weed estimated to be present. The most prolific area apparently is in North Uist, where Loch Maddy and Loch Eport support a total of about 60,000 tons of littoral weed. On the basis of this estimation and full-scale trials now nearing completion it may be feasible to establish a harvesting and processing unit in Loch Maddy. One of the most prolific areas for sub-littoral weed is likely to be found around the Orkney Islands, where the sea-bed between one and six fathoms (low water) has been estimated to support well over 1,000,000 tons, perhaps nearly 2,000,000 tons, of seaweed of the family Laminariaceæ. The species of this family most common to the Scottish coast do not apparently grow in measurable quantities below nine fathoms (low water), and to harvest at depths below six fathoms (low water) would be quite uneconomic. A further survey of the sub-littoral seaweed growth around the Orkney Islands, and, if possible, of other rich algæ-bearing areas in Scottish waters, is part of the programme of the algologists for 1947–48, using techniques developed in the Association's laboratories. Other aspects of their researches include a survey of the cast seaweed during the winter months of 1947–48, a determination of the rates of regrowth and recolonization of the Fucaceæ of Orkney, an estimation by controlled cultural methods of the minimum requirements for successful growth and development of the British Laminariaceæ from zoospore stages, and the induction of polyploidy in the Laminariaceæ by chemical and physical means. Moreover, several extra-mural investigations are in progress. Dr. Delf and Miss Moss of Westfield College, London, are studying the concentration gradients and constitutional and physiological differences in the Fuci from areas of varying exposure, and Prof. Bennet-Clark and Mrs. Milnthorpe, of King's College, London, the metabolism of respiration of the Laminariaceæ.

Meantime, one can say with safety that the Botanical Division has shown that sufficient seaweed is available in Scotland to make the seaweed industry a commercial proposition, *if the seaweed can be harvested*.

The harvesting of the seaweed is, of course, the second of the two main tasks confronting the Association, which stands or falls by its ability to solve the problem. This is the problem of the Engineering Division headed by the deputy director of the Institute, with Mr. Wm. Mackenzie, who has been with the Association since its inception, as second in command. Seaweed growing in the littoral zones is comparatively easy to harvest, and methods of harvesting have already been devised and are being developed. Sub-littoral seaweed, growing on the rocky sea-bottom at depths of between one and seven fathoms (low water), is much more difficult to harvest. In most parts of the Scottish coastline it grows fairly close inshore and necessitates the use of powerfully engined, shallow draft, and easily manœuvrable vessels. Therefore, before embarking on a costly series of experimental investigations, the Engineering Division has contacted upwards of thirty engineers and interested members of other professions in the universities and colleges, Government departments, Government and other research organisations and in industry with the view of obtaining as many suggestions and constructive criticisms of existing ideas as possible. As a result, the problem has been considerably clarified, and now six possible methods have been evolved which are considered worthy of full-scale investigation. Already the first two experimental units, operating on different principles, have been designed and all the necessary equipment ordered, and shortly the first trials will start off the west coast of Scotland. Meantime, during much of the past year the engineers have had to devote themselves to matters associated with the lay-out, furnishing, servicing, equipping and the adaptation of Inveresk Gate to the Association's needs.

Assuming, then, that the necessary apparatus for the harvesting of the sub-littoral seaweed will be evolved, the main object of the Scottish Seaweed Research Association will be the development of seaweed as a source of chemicals. So far, the only seaweed product that is being used commercially on a large scale is alginic acid; but for every ton of this acid which is extracted, there are three tons of potentially useful chemicals running to waste. Obviously, the Chemical Division, headed by Dr. W. A. P. Black, has a huge field for research, and many problems have been initiated. Several of these are extra-mural investigations at certain universities and research establishments, either on a contractual or on a collaborative basis. Dr. Percival, at the University of Edinburgh, has developed accurate methods for the estimation of alginic acid, laminarin and mannitol, and is also directing research on fucoidin. At the University of Manchester, under the direction of Prof. E. L. Hirst, the chemistry of alginic acid and laminarin was being investigated. Perhaps this work will now also be conducted in Edinburgh, in view of Prof. Hirst's recent appointment to the new Forbes chair of organic chemistry in this University. At the Imperial College of Science and Technology, Sir Ian Heilbron and his colleagues Dr. L. N. Owen and Dr. A. H. Cook are studying the brown seaweed lipoids and the chemistry of the algal reproductive processes. Algal sterols are being studied at King's College, London, by Prof. D. H. Hey; while at University College, Nottingham, Dr. D. O. Jordan with the late Prof. J. Masson Gulland was attempting to isolate and identify the unknown constituents of the brown seaweeds by electrophoretic methods.

During the past two years the staff of the Chemistry Division has been working on the seasonal variation in the composition of some common brown algæ. For example, in 1946, some 144 samples of littoral weeds of the family Fucaceæ, *Pelvetia canaliculata*, *Fucus spiralis*, *F. serratus*, *F. vesiculosus* and *Ascophyllum nodosum*, and of sub-littoral weeds of the family Laminariaceæ, *Laminaria digitata*, *L. saccharina* and *L. Cloustoni*, have been collected and prepared under strictly controlled conditions, and their dry weight,

ash, iodine, nitrogen, mannitol and alginic acid contents determined. It is of interest to note that the results recorded for 1946 are comparable with those obtained for 1945; indicating that the results may be approximately reproducible in subsequent seasons.

Another problem of much scientific and technical importance is a study of the variation in the composition of the sub-littoral seaweeds with depth of immersion. So far, the results obtained substantiate the hypothesis that, consequent upon depth of immersion, there is a decrease in light intensity affecting the photosynthetic processes, which is reflected in the composition of the weeds.

The above programmes of research and development have been approved by the Board of Management under the chairmanship of Sir Steven Bilsland, who is also chairman of the Scottish Council (Development and Industry), as well as by the three specialist Advisory Committees, Algological, Chemical and Engineering. At the official opening of the Institute, Sir Steven emphasized that Scottish seaweed could provide an industry worth £15,000,000 per annum. Of this sum one third would go to collectors. In all, 90 per cent would be spent in Scotland and only 10 per cent outside Scotland.

Thus, for the first time, there has been sponsored in Great Britain an organisation set up to develop an industry based on waste, indigenous, natural products. It is interesting and suggestive to recall that it is now more than sixty years ago (1884) since Stanford, employed in the Scotch kelp industry, first discovered algin and some of the substances contained therein—calcium, magnesium and sodium in combination with the new alginic acid.

H. R. Fletcher

MECHANISM OF COLOUR VISION

ALTHOUGH some references were made to visual investigations carried out for the Forces during the War, the International Conference on Colour Vision held at Cambridge during July 28–August 2 was concerned mainly with the fundamental problem of how the visual mechanism works and, in particular, with the apparatus by which differences of colour are perceived.

R. Granit (Stockholm) reviewed the outstanding new development in this field, the work which he and his school have carried out on the electrical response of single fibres of the optic nerves of experimental animals such as the frog, cat, snake, etc. The response is picked up by applying a micro-electrode to the retina of an eye from which cornea and lens have been removed. Potential spikes generated between the micro-electrode and a second electrode, placed usually at the back of the bulb, may occur only on illuminating the retina (pure on-elements), or only on cutting-off the illumination (pure off-elements), or after both these operations (on-off-elements). But in every case a spectral sensitivity curve for the element which the micro-electrode has contacted can be measured by finding the smallest energy of various wave-lengths which just suffices to elicit a minimal characteristic response. Certain signs, for example, a single spike response at the threshold, enable the experimenter to decide whether the micro-electrode is in contact with the fibre of a single ganglion cell.

The following types of spectral sensitivity curve are obtained: (*a*) *scotopic dominator*, a broad curve which by its shape and position in the spectrum and by its appearance in rod retinæ and under conditions of dark-adaptation can be attributed to ganglion cells associated with end-organs for which visual purple (or for freshwater fish, visual violet) is the photosensitive substance; (*b*) *photopic dominator*, another broad curve, obtained with light-adapted and predominantly cone retinæ, which is displaced some 60–70 mμ towards the red compared with the scotopic dominator of the same retina (when this can be recorded); (*c*) *modulator curves*, comparatively narrow curves obtained with light-adapted retinæ and located at various points of the spectrum from about 440 to 610 mμ, possibly in groups in the red, green and blue regions; (*d*) *composite curves*, which can be regarded as the 'summation' of a dominator and a modulator or of two modulators.

From replies to questions on the relative frequency with which dominator and modulator curves are obtained, it appeared that perhaps one in twenty curves (presumably for light-adapted retinæ) would be of modulator type. A new worker in this field, de Vries (Groningen) reported that he had had no difficulty in obtaining dominator curves, but had not yet observed a modulator curve.

Some criticism was expressed of Granit's second method of obtaining modulator curves, the method of selective adaptation. The modulator curve is derived by taking at each wave-length the difference between (*a*) the sensitivity (reciprocal threshold energy) of an element after strong adaptation to coloured light, and (*b*) the reduced sensitivity of the same element in the fully dark-adapted state, that is, the dark-adapted sensitivity reduced by a constant factor so chosen that the difference in question is zero at some wave-length and is nowhere negative. One of several assumptions underlying this procedure is that both rods and 'modulator receptors' are connected to the ganglion cell, the fibre of which is in contact with the micro-electrode, and that the effects of radiational quanta absorbed in rods and modulator receptors are summed at the threshold just as if they were all absorbed by a single end-organ.

Pirenne (London) and others found this latter assumption difficult to accept. Apart from the difficulty of justification, however, the procedure used leads to modulator curves for the cat's retina which are very similar to those obtained for other retinæ by the direct method.

Certain main trends relating the on-or-off character of an element with its spectral response and other properties had been observed. Thus pure on-elements were strongly predominant in pure rod retinæ, while pure off-elements were common in retinæ having no rods. Taking as standard the spectral sensitivity curve corresponding to light absorption by visual purple, Granit and Tansley (Birmingham) found that off-responses, particularly those from pure off-elements, were in general relatively red-sensitive, but on-responses, if they deviated at all, did so in the direction of blue-sensitivity. From these and similar results Granit was led to group together rods, on-effects and blue-sensitivity on one hand, cones, off-effects, inhibition and red-sensitivity on the other.

In the latest micro-electrode work, Granit and Gernandt (Stockholm) had found that if, instead of illuminating the retina, a polarizing current of about 0·1 mA. was passed through it, on-elements gave an on effect and off-elements an off effect for one

direction of the polarizing current and the reverse effects when the current was reversed. On-off-elements behaved to the polarizing current either like on-elements or like off-elements, depending on the relative strengths of their on- and off-responses to the ordinary light stimulus. The effect of a polarizing current on the spectral sensitivity curve of an element was expressed by taking at each wave-length the *ratio* of the light thresholds with and without polarizing current. The ratio curves so obtained show peaks and depressions at various parts of the spectrum, different for different current directions and for elements of different type. These peaks and depressions are assimilated to the modulator curves obtained by the method of selective adaptation. In Granit's view the polarization method provides the most satisfactory way of determining modulators. The bearing of the polarization results on the question of inhibition in the neural network of the retina was also discussed by Granit.

A paper by Polyak (Chicago) on retinal structure and colour vision was read by Le Gros Clark (Oxford). Le Gros Clark also summarized the evidence for his interesting suggestion that conduction from the central retina is mediated by three-fibre units, the respective fibres terminating in corresponding cell layers of the lateral geniculate body, and that this triplicity is closely related to the trichromatic basis of colour vision. One supporting observation was obtained from a war-time experiment in which monkeys kept in red light for some weeks showed, in two out of three animals, a degeneration of the cell layers associated by other evidence with the 'blue' mechanism. Oddly enough, this presumed atrophy by disuse affected mainly the layer of 'blue' cells receiving crossed fibres. Two of the main points made by Polyak were that in the extrafoveal retina the ganglion cells are generally connected through bipolars to both rod and cone end-organs, and that in the central fovea the end-organs are structurally indistinguishable, although connected in different ways through bipolars to the ganglion cells.

The latter conclusion cuts across the hypothesis recently developed by Willmer (Cambridge), according to which the end-organs of the central fovea are of two kinds, cones and non-adapting or day rods. Willmer suggested that the staining reactions used by Polyak to identify rods might pick out only those which have the capacity of accumulating visual purple in the dark and might fail for day-rods. Willmer, after summarizing the phylogenetic argument for his hypothesis, presented some new sensory measurements on the luminosity curves of colour-blinds obtained with small test fields in the central fovea. Under these conditions, normal trichromats behave like dichromats (tritanopic), while dichromats are reduced to monochromats. The differences in the luminosity curves of various colour-defectives were correlated by Willmer with the several possible end-organ-ganglion cell systems consistent with his hypothesis. Also the actual shapes of the curves were related to the absorption curves of rhodopsin and iodopsin.

In the discussion, this last step was strongly criticized for the same kind of reason as already noted in connexion with Granit's derivation of modulator curves by selective adaptation. In fact, one main impression from the Conference was that workers on vision have been prone to take differences of experimental curves or to apply other mathematical manipulations to their data without a proper discussion of the kind of summation, inhibition or other process which is automatically assumed to occur in the organism whenever particular mathematical methods are applied.

Wald (Harvard) reviewed the considerable knowledge we now have of the rhodopsin–retinene$_1$–vitamin A$_1$, and the porphyropsin–retinene$_2$–vitamin A$_2$ photochemical systems of the retina. Morton (Liverpool), who has recently obtained retinene$_1$ in the crystalline state, explained briefly his reasons for attributing to retinene$_2$ a structure differing from retinene$_1$ by one additional conjugated double bond in the ring. The extraction by Bliss (Boston, U.S.A.) of a substance termed cephalopsin, a kind of non-bleaching visual purple, from the eye of the squid raised interesting possibilities. No substantial advance in the difficult problem of extracting from the retina photosensitive substances which might be assigned to cones or to hypothetical end-organs possessing spectral sensitivities of modulator type was reported. Wald showed how measurements of the absolute light threshold in the visible and ultra-violet for parafoveal rod vision and foveal and parafoveal cone vision on normal and aphakic eyes led to determinations of the absorption curves of the macular pigment and of the eye lens. The results were in satisfactory agreement with his direct measurements on preparations from human eyes. The macular pigment could be identified as a xanthophyll, probably ordinary lutein.

Turning to purely sensory studies of colour vision, MacAdam (Rochester, U.S.A.) explained how by the use of Landolt test objects (*a*) of usual type, (*b*) with the broken circle of one colour and the background of different colour but equal brightness, he had succeeded in comparing the visual acuities attributable respectively to pure brightness and pure colour contrast. Taking as standard the relative importance of colour and brightness contrast in determining the observed discrimination in a 2° colorimeter field, colour contrast was found to be much less effective in the acuity observations, which depend on discrimination in small areas. At the other extreme of large non-contiguous areas, colour contrast was much more effective than brightness contrast. As fixation was not controlled in the acuity measurements, the results were not directly comparable with those of Willmer and Wright (London) showing tritanopic colour defect in the central fovea, and, in fact, the loss of colour discrimination was not of this specific type.

Wright considered the recent work on colour matching and discrimination in small fields in his talk on the present status of the trichromatic theory. His general conclusion was that the theory in some form is necessary to explain some of the known facts and, at the same time, it is not inconsistent with much of the remaining data. According to Stiles (Teddington) the observed foveal thresholds of a coloured light patch superimposed on an adapting field of, in general, a different colour are consistent with a classical trichromatic theory and lead to fundamental response curves of Kŏnig type. But from the threshold recovery curves obtained after extinguishing the adapting field, it appears that the 'blue' mechanism has very different dynamics from the 'green' and 'red' mechanisms, a result already indicated by Wright's studies of colour adaptation by the binocular matching method. The difficulty of reconciling three fundamental response curves which are widely separated in the spectrum (for example, curves of

König type) with the apparent saturations of different spectral colours was enunciated by Hecht (New York), who also raised the problem of the sensations experienced by subjects with one normal and one colour-defective eye.

In the discussion two issues were separated: (*a*) differences in the number of just perceptible colour steps between white and the various spectrum colours; (*b*) the relation between the descriptions of colour sensations given by normals and various types of colour-defectives. Wright argued that attempts to explain (*a*) on the basis of the trichromatic theory, while not without some success, were too mechanistic. On (*b*), it was suggested that the colour names applied by colour-defectives are determined during the development of the individual so as to give, under the conditions of everyday life, the greatest measure of agreement with the names used by colour normals; or, in the case of a single defective eye, maximum agreement between the names which would be applied when the two eyes were used in turn.

Judd (Washington, U.S.A.) found the explanation of the colour sensations experienced by colour-blinds the principal stumbling-block to the interpretation of dichromatic vision on the trichromatic theory. He summarized several alternative views according to which a different form of explanation of colour vision is required for the various stages (photosensitive, substance, receptor, optic nerve, cortex) of the visual process.

By measuring the foveal threshold sensitivity through the spectrum, Hecht had deduced that the effective luminosity of an equi-energy spectrum would be, for the protanope, about one half and, for the deuteranope, about three fifths that of the normal. On the assumption that luminosity is the dominant factor in determining differences of visual acuity between normals and colour-defectives, he tested and confirmed this result by acuity measurements on subjects of the three types. de Vries determined the modification in brightness match between green and red stimuli when the matching field was covered by a veiling brightness of red or blue light. The modified matches agreed with those obtained in the absence of the veiling brightness by protanopes and deuteranopes respectively. This result and that of Hecht appear to support the simple theory of dichromatism as the loss of a receptor system.

Pitt (Harrow) developed the interesting suggestion that for protanomalous trichromats only the 'red' fundamental response curve is aberrant, this curve being related to the corresponding normal curve by some modification of form, progressive with increasing anomaly, and perhaps resembling the change of the absorption curve for a layer of increasing thickness. Schouten (Eindhoven) put forward related ideas for both deuteranomalous and protanomalous cases. Hecht questioned the usual interpretation of anomaloscope studies of large groups as showing a continuous transition between the normal and the anomalous. By taking account of the whole range of uncertainty in each subject's setting of the anomaloscope, he concluded that the groups are clearly separable without overlap. Farnsworth (New London, U.S.A.) showed a pseudo-isochromatic chart, which he had designed and made up from Munsell colour patterns, for the detection of tritanomalous subjects, a type which is likely to have escaped earlier tests of colour defect. The genetics of colour vision were not discussed in any detail, but Kalmus (London) made a plea for the study of the colour vision of heterozygous females.

Of the several points raised by Hartridge (London) in developing a polychromatic theory of vision, his use of the negative values in sets of fundamental response curves like those of Wright as an argument for additional receptor mechanisms was not generally acceptable. On the other hand, Dimmick (New London, U.S.A.) and Schouten were sympathetic to certain aspects of the theory, which they consider are in better accord than the usual trichromatic presentation with the psychological analysis of sensation.

Measurements, by a new method, of the chromatic aberration of the eye, which is of particular importance in the recent studies of colour in small fields, were presented by Ivanoff (Paris). His results agreed satisfactorily with other new measurements by American workers. Hecht, Shaer, and Pirenne's notion of quantum fluctuations in the stimulus as the main factor in determining the intrinsic indefiniteness of absolute threshold values was discussed by Van der Velden (Utrecht) and Bouman (Utrecht). By extending the theory to take account of variations of threshold with the area and exposure-time of the test stimulus, they conclude that the absorption of two quanta is sufficient to initiate a response. Hecht reported new work on the effects on the threshold of the size and shape of the test stimulus. He found that the dominant factor is the length of the boundary edge rather than the area.

It was a great pleasure to all present to have the Conference opened by the veteran of the subject, Sir John Parsons.

W. S. STILES

OBITUARIES

Dr. Ellsworth Huntington

DR. ELLSWORTH HUNTINGTON, who died recently at the age of seventy-one, was well known for his views on the dominant effect of climate on human affairs. As a student of geography under Prof. W. M. Davis, he spent the years from 1900 to 1906 in the exploration of Asia Minor and Central Asia, his first paper being an account of the Upper Euphrates published in 1902. In Central Asia he was struck by the evidence that large populations formerly inhabited regions now arid and deserted, and from these and other historical studies, including the changes of level of the Caspian Sea, he developed the theory that during the past few thousand years there have been great oscillations of climate. These researches were published in "The Pulse of Asia" in 1907 and aroused much controversy among geographers. In the following years he extended his studies of climatic change to Palestine and North America, and he was one of the pioneers in the measurement of tree-rings as climatic indicators. These researches led him to the view that the ideal climate for human vigour is one of moderate but rapidly fluctuating temperatures, which is best developed in the storm-belts of temperate latitudes; and in "Civilization and Climate" (1915) he compared estimates of the level of existing civilizations in different countries, obtained in various ways, with their level of climatic energy, finding remarkably close agreement. In the same book he extended his studies of the effect of climatic changes on the history of ancient civilizations, including a new version of the decline and fall of the Roman Empire.

Huntington followed up these ideas in great detail in a series of articles and books—"World Power and Evolution", "The Pulse of Progress", "Weather and Health", "Season of Birth", "Mainsprings of Civilization", etc. He believed that the origin of climatic variations was to be sought in the sun, and especially in shifts of the storm belts associated with changes in sunspot activity. This hypothesis fits well enough with historical changes of climate; but he stretched it too far when, in conjunction with S. S. Visher, he based a theory of ice ages on increases in the number of sunspots. His rather wild hypothesis of the electro-magnetic influence of the fixed stars on solar radiation found no favour with astronomers. In his later years Huntington became interested in the study of weather cycles, and he was one of the originators of the Foundation for the Study of Cycles which was established in the United States.

Huntington's books were all eminently readable and full of ideas, but at times his claims were exaggerated; for this reason his books had less influence than they might have done had they been phrased more cautiously. On the other hand, he did much to arouse interest in historical variations of climate. In the early 1900's, climate was generally believed to have remained static for thousands of years; "The Pulse of Asia" shattered this calm and began a controversy which has added much to our knowledge.

C. E. P. Brooks

We regret to announce the following deaths:

Mr. William Densham, who assisted Marconi in his early experiments in the Isle of Wight, at Poldhu, Clifden and in America, on October 25, aged seventy.

Prof. Henryk Hoyer, emeritus professor of comparative anatomy of the Jagiellonian University, Cracow, widely known by his work on the comparative anatomy of blood and lymph vessels of vertebrates, on October 17, aged eighty-three.

Sir Leonard Pearce, C.B.E., engineer-in-chief to the London Power Company, who was responsible for the engineering design of the Battersea Power Station, on October 20, aged seventy-four.

NEWS and VIEWS

The Royal Wedding

Since attaining her twenty-first birthday in April of this year, during the tour of the Royal Family in South Africa, Princess Elizabeth has been taking a prominent part in many public functions. Thus apart from the general affection among the public which has been inspired by the sympathetic understanding and devotion to duty of the Royal Family, the people at large have had increased opportunities of learning to know Princess Elizabeth. In these pages it is appropriate to refer particularly to her association with, and interest in, scientific and similar bodies. Early this year, she was elected an honorary member of the Institution of Civil Engineers, and shortly afterwards she became a Royal fellow of the Royal Society. She has also accepted the office of president of the Royal Society of Arts, the activities of which were of deep concern to Prince Albert and in memory of whom the Society's premier award, the Albert Medal, was founded. In her address from the chair at the opening meeting of the present session of the Society, she stressed the importance of design, not only from the point of view of usefulness, but also from that of æsthetics. The industrial revolution, she said, had left a legacy of squalor, misery and ugliness, which was followed by a fall in standards of taste accompanying mass production methods. It is our duty to lead the world in finding a remedy and "to establish that beauty is as essential to utility as it proverbially is to truth". Scientific workers will wish to be associated with the good wishes which are being conveyed to Princess Elizabeth and Lieut. Philip Mountbatten from every part of the world on the occasion of their marriage.

Scientific Adviser to the Ministry of Food: Dr. N. C. Wright

Dr. N. C. Wright, director since 1928 of the Hannah Dairy Research Institute, Ayr, has recently been appointed to succeed Sir Jack Drummond as scientific adviser to the Ministry of Food, being seconded during the period of this appointment from the directorship of the Institute. Dr. Wright is a graduate of Oxford, and during his post-graduate training, carried out research in biochemistry at Cambridge, at the National Institute for Research in Dairying, Shinfield, and in the United States, where he held a Commonwealth Fund Fellowship during 1926–28. While at Shinfield, he investigated, with Mr. W. L. Little, the etiology of milk fever in cattle. These investigators were the first to point out the fall in blood calcium accompanying this disease, a discovery which laid the foundation for the modern method of treatment. Dr. Wright was appointed first director of the Hannah Institute in 1928, and the noteworthy progress of that Institute has been largely due to his efforts. He and his collaborators have, among other researches, examined the influence of heat on the behaviour of milk proteins, the mechanism of the secretion of calcium, phosphorus and other milk constituents by the mammary gland, the differences in biological value for milk secretion of various mixtures of food proteins in common use in the rations of dairy cows, and they have made valuable contributions to knowledge in each of these fields.

Dr. Wright has also in recent years studied the questions, at present of great national importance, of the feeding-stuffs requirement of farm animals in relation to home and overseas supplies, and the rival claims, under war-time conditions in Britain, of animals and man for food. His appointment at the Ministry coincides in time with the agricultural expansion programme for greater home production of food, a programme which largely depends for its implementation on the increased importation from overseas of animal feeding stuffs. Dr. Wright's recent studies will doubtless be of especial value in relation to this importation, which is a function of the Ministry of Food. Since 1936 he has paid several advisory visits overseas: to India, the Middle East, Ceylon, and recently to Greece with a mission of the United Nations Food and Agriculture Organisation, mainly in connexion with food production and livestock problems.

Discovery of Chloroform Anæsthesia

THE discovery of the use of chloroform as an anæsthetic, made by Sir James Young Simpson in Edinburgh in 1847, was marked by a graduation ceremony at the University at which the honorary degree of LL.D. was conferred on Dr. H. W. Featherstone, founder-president of the Association of Anæsthetists of Great Britain, and Mr. T. B. Simpson, a grand-nephew of Simpson. A meeting to discuss the present-day use of chloroform was also held, at which Prof. R. R. Macintosh (Oxford) and Drs. D. S. Middleton and John Gilles (Edinburgh) read papers. Dr. Douglas Guthrie, lecturer on the history of medicine in the University of Edinburgh, gave an address at a reception in the Upper Library, where an exhibition of Simpson relics had been arranged. Dr. Guthrie said that the discovery of chloroform anæsthesia was one of the most dramatic episodes in the history of medicine, and with antiseptics had revolutionized surgery; it was remarkable that it had been delayed until the middle of last century. After graduating M.D. at Edinburgh in 1832, Simpson became assistant to Prof. John Thomson, professor of pathology, who advised him to specialize in midwifery. He was appointed professor of midwifery in the University in 1840, a post which he held until his death at the early age of fifty-nine in 1870. Since the discovery by Simpson of the anæsthetic properties of chloroform, there have been great advances in the technique of its administration, to which he himself contributed; and in spite of the introduction of many new substances, it still holds its place as a general anæsthetic.

Carl Friedländer (1847–87)

FRIEDLÄNDER'S name is familiar to every medical student through 'Friedländer's bacillus', which he described in 1882. A capsulated micrococcus, this is not now considered pathogenic for true lobar pneumonia, though it may cause the accompanying septicæmia. A native of Brieg in Silesia, Carl Friedländer was born a century ago on November 19, 1847. After taking the M.D. at the University of Berlin, he became assistant to Friedrich von Recklinghausen at Strassburg in 1874, and five years later was appointed to the modest post of assistant superintendent of post-mortem examinations in the Friedrichshain Hospital, Berlin. The courtesy title of professor was conferred on him only a few months before his death. Founder-editor of the *Fortschritte der Medicin*, Friedländer brought that journal to the front rank of German scientific periodicals. Among his most original work may be mentioned his description of thromboangiitis obliterans and his recognition of the tuberculous nature of lupus. He himself was a victim of pulmonary tuberculosis, which first manifested itself about 1882. His "Mikroskopische Technik" was a manual valued by student and expert alike.

Dr. Charles Creighton (1847–1927)

FOUNDER of modern British epidemiology, Charles Creighton, who was born on November 21, 1847, towered above his fellows yet partook of their foibles and frailties. After obtaining the M.D. at Aberdeen in 1878 and studying in Berlin and Vienna, he practised for a time in London, but his heart was never in his work. He practically lived in the British Museum, where he collected material for his "History of Epidemics in Britain" (1891–94), described by Garrison as a "classic of unimpeachable accuracy". To the gigantic task of translating unaided Hirsch's "Handbuch der historisch-geographischen Pathologie" for the New Sydenham Society he devoted twelve hours a day for three years. He was the most learned British medical scholar of the nineteenth century, who stood for something fundamental in the intellectual world of his generation. He was handicapped, however, by a curious mental obliquity which forced him to believe that the generally accepted must be necessarily false. Incapable of sharing much of the current medical teaching and frequently clashing with his medical colleagues, he brought matters to a head when in his article on vaccination in the "Encyclopædia Britannica" he declared that cowpox had nothing to do with smallpox, affording no protection against it. This was acclaimed by the antivaccinators, and Creighton was ostracized by the medical profession. He spent his last years in philosophical isolation in a tumble-down cottage at Upper Boddington, turning to Shakespeare for solace. His slender means were amplified by a Civil List pension secured for him by Mr. Asquith, who admired his learning.

Hop Research in Britain

A NEW research centre has been set up for hop production problems. It is situated at Wye College, Kent, and is to be administered by the College. The Ministry of Agriculture, the Hops Marketing Board and the Institute of Brewing will provide grants to meet the costs of maintenance, and the two last-named will bear the capital costs of establishing the centre. Scientific advice on the programme of work of the new centre and the staff necessary to carry out that programme will be given by the Agricultural Research Council; to assist on technical matters, the Council has a Committee on Hop Research, on which there are members nominated by the grant-making bodies. The investigations at the new centre will include those concerned with soils, cultivation, varieties, breeding, diseases, brewing qualities and storage, and there will be close co-operation with investigations on hop diseases carried out at the East Malling Research Station or elsewhere.

Atomic Energy Train Exhibition

THE atomic energy exhibition, organised by the Atomic Scientists' Association, was launched on November 6 at Liverpool by Sir James Chadwick. Speaking of the purpose of the exhibition, Sir James remarked that the excursion of scientific workers from the lecture room and the laboratory into the hurly-burly of public life was forced upon them by the urgency of the situation. Sooner or later the countries of the world will have to come to a decision about atomic energy, the trend of its development and the use to which it is to be put. This decision will have an important effect on the relations between nations and on the establishment of goodwill and confidence between them. In order to come to a wise decision it is necessary that the people at large should understand the fundamental facts. It is one of the aims of the Atomic Scientists' Association to explain to the public the facts about atomic energy. The main feature of the exhibition is the inclusion of experiments of the same type that are used in the laboratory. The first of the two coaches deals with the fundamental facts about atomic energy, and in it several Geiger counters are employed in order to demonstrate radioactive phenomena. The production

of artificial radioactivity in silver by bombardment with slow neutrons is also demonstrated. The second coach deals with the practical applications of atomic energy, and it starts with a demonstration of the detection of fission in uranium. The gas diffusion, thermal diffusion and electromagnetic methods of isotope separation are all demonstrated on working models. The application of radioactive elements to medicine is illustrated on a film. All experiments are arranged to run automatically, but a member of the Atomic Scientists' Association is in attendance to give additional explanations.

The exhibition was first open to the public in Chester on November 10. It went from there to Stoke, and its further itinerary includes Manchester, Blackpool, Carlisle, Glasgow, Dundee, Aberdeen, Edinburgh, Newcastle, Middlesbrough, York, Leeds, Sheffield, Derby, Coventry, Nottingham, Leicester, Birmingham, Shrewsbury, Swansea, Bristol, Cardiff, Oxford, Reading and London. Efforts are being made to extend the duration of the exhibition to enable it to visit more places in the south of England. Inquiries about the exhibition should be addressed to Dr. J. Rotblat, Physics Department, University of Liverpool.

Starch Hydrolysis by Polarized Light

It has earlier been reported that exposure to polarized light induces hydrolysis of starch both *in vitro* and in the mesophyll of leaves. Now Dr. Elizabeth S. Semmens (*Plant Physiology*, **22**, 270–278; 1947) describes experiments on the effect of polarized light on the starch content of stomatal guard cells. With a variety of plants and using both detached strips of epidermis and whole leaves attached to the parent plants, polarized light induces starch hydrolysis in the guard cells of the stomata; and this hydrolysis is accompanied by stomatal opening. Although in some cases the periods of exposure that preceded the observations were somewhat prolonged, these effects were also found when the period of exposure was only a few hours. With polarized direct sunlight the starch hydrolysis proceeded more vigorously, and bursting of the guard cells sometimes occurred. Although it appears likely that these observations, regarded as preliminary by the author, may, when extended, make a contribution to our knowledge of the vexed problem of stomatal mechanisms, their precise significance is at present difficult to assess.

Dominion Observatory, Wellington

The annual report for the year 1944 of the Dominion Observatory, Wellington, N.Z., shows that there was a general decline in seismic activity as compared with previous years. There was some concentration of activity south of Lake Taupo, but the intensity anywhere did not exceed V + on the modified Mercalli scale and the shocks were not destructive. Sixty-one tremors were felt in the North Island, forty in the South Island and six in both. The Jaggar seismograph at Hastings was in operation again by July and the seismographs at Auckland, Arapuni, Tuai, New Plymouth, Bunnythorpe, Wellington, Takaka, Kaimata, Christchurch and Monowai were recording throughout the year. The death occurred on May 24, 1944, of Mr. A. W. Burrell of Stratford, who for some time operated a Jaggar seismograph for the Department of Scientific and Industrial Research in the Dominion.

National Museums of Ceylon

This Director's report for 1945 (published 1946) on the national museums of Ceylon includes the Colombo, Kandy, Ratnapura, Jaffna and Navala Museums. All have suffered, in varying degrees, the difficulties associated with requisition, evacuation, or other war-time contingency, and in some cases results have been serious. The present report, however, shows that these institutions are now returning to their normal peace-time activities. From the Colombo Museum, for example, it is reported that the important work on the Museum's collections in relation to Ceylon's extinct mammals, living fauna, prehistory and certain antiquities, was resumed and the results published during the year. Damage and losses are still being assessed in this Museum, and the Jaffna Museum reports that only a very small part of the Twynam collections (stored in the Old Dutch Church) will be fit for exhibition again. Lists of acquisitions in respect of each museum are given in detail.

Anthropological and Archæological Work in India

The *Journal of the Indian Anthropological Institute*, vol. 1 (New Series), 1945, contains a number of interesting articles. Desiccation of Asia and its effect on human occupation is discussed by the late Sir Aurel Stein. Colonel Gordon surveys ancient Gandhara, and also describes some rock engravings and microliths in the Bangalore area. Colonel Gordon has long ago shown that most of the rock-shelter paintings and the rock carvings in India cannot be of any considerable antiquity. Nevertheless, such finds are of great interest, even if not very ancient. There are also papers on megalithic monuments of southern India by A. Aiyappan, and on Gond exogamy by M. P. Buradkar.

French Scientific Library in London

A small French scientific library is being built up at the Institut Français du Royaume-Uni, London. Both books and periodicals can be borrowed by post. In addition, microfilms of articles appearing in periodicals not available in the library can be obtained from France. These can either be consulted in the library, where a microfilm reader has been installed, or borrowed by post. All the library services are provided free. A catalogue of the books and periodicals available can be obtained from the Librarian, Scientific Library, Institut Français du Royaume-Uni, Queensberry Place, South Kensington, London, S.W.7.

Institution of Civil Engineers: Council for 1947–48

The Council for 1947–48 of the Institution of Civil Engineers is as follows: *President:* Sir Roger Hetherington; *Vice-Presidents:* Sir Reginald Stradling, Sir Jonathan Davidson, W. H. Morgan, V. A. M. Robertson; *Other Members of Council:* H. E. Aldington, Sir Stanley Angwin, Prof. J. F. Baker, G. Baxter, D. B. Brow (India), W. S. Cameron, F. M. Corkill (New Zealand), H. F. Cronin, Sir Arthur Dean (India), Dr. W. H. Glanville, A. Gray (Canada), Dr. E. J. Hamlin (South Africa), A. C. Hartley, G. H. Humphreys, Sir Claude Inglis, L. Leighton, H. J. B. Manzoni, M. S. Moore (Australia), Prof. A. J. S. Pippard, A. S. Quartermaine, J. C. L. Train, W. K. Wallace, Sir Arthur Whitaker; *Past-Presidents:* Dr. D. Anderson, F. E. Wentworth-Sheilds, Sir Peirson Frank, Sir William Halcrow; *Secretary:* E. Graham Clark.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A New Technique for Studying the Helium Film

In previous experiments the properties of the helium film and the mechanism of the transport in this film have been investigated systematically[1]. However, all these measurements were carried out with the bulk liquid present, and the film was therefore always under the vapour pressure of the latter. We have now developed a technique which permits the study of the film in equilibrium with the gas phase only, thus reducing the observations to the simpler case of a two-phase (film-gas) equilibrium. Use is made of the frictionless flow of the film through capillary leaks below the λ-point.

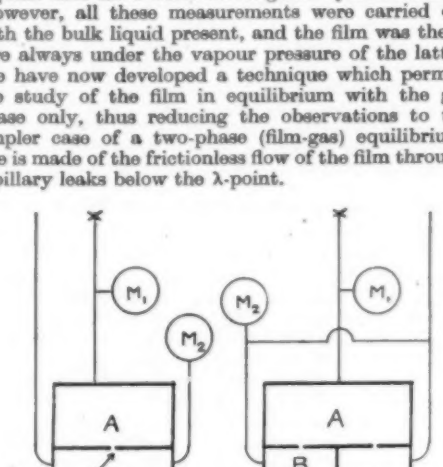

Fig. 1

Fig. 2

Two containers, A and B (Fig. 1), the latter containing liquid helium I, are connected by the capillary leak L. If A is evacuated and then closed off, helium *gas* will leak from B through L into A, the rise of pressure in A being measured by the gauge M_1. When the liquid helium in B is cooled below the λ-point, however, a new process makes its appearance. Helium in the form of the transfer film now runs up the sides of B and passes over the perimeter of L into A, thereby constituting an additional leakage. By using progressively smaller capillary leaks, the stage can be reached where the gas leakage becomes insignificant compared with the film leakage, and it is then possible to study the film in A under varying gas pressures independent of the vapour pressure of the liquid. Tubes containing closely packed wires such as used by Allen and Misener[2] in their work on the viscosity of the bulk liquid were found to provide suitable capillary leaks.

The first experiments undertaken were determinations of the equilibrium pressure which will be set up in A through film leakage from B; that is, the vapour pressure of the film. However, some of the results obtained at first sight appeared quite paradoxical. In a number of experiments, the pressure in A rose not only to the value of the vapour pressure in B, which was measured independently on the gauge M_2, but surpassed it, settling at a higher value. The reason for this curious behaviour was indicated when it was found that in these cases, owing to the heat influx from outside, the container A was slightly warmer than the liquid in B. By purposely increasing the temperature of A, it could be made to fill up to an equilibrium pressure more than twice as high as the vapour pressure in B. Daunt and Mendelssohn[1] have found that there exists a thermo-mechanical effect in films similar to the fountain effect in the bulk liquid[3], and it would seem that in the present case helium is transferred by the film to a region of higher temperature and consequently higher vapour pressure. This observation raises the interesting question (to be settled by further experiments) as to whether under these conditions the helium in A will appear in the form of bulk liquid, and whether there exists a temperature gradient in the transfer film itself.

The new technique of studying the helium film can be applied to a wide range of problems. For example, by introducing a second capillary leak (Fig. 2) leading into a third container C, which is also filled with liquid helium II, but at a lower liquid level than that in B, the transfer of liquid by means of the film from B through A into C can be studied. Preliminary experiments have shown that the transfer persists even when the pressure in A is reduced below the vapour pressure of the bulk helium. Other experiments under way concern the actual temperature of the film under various conditions and the speed of heat impulses along the film with the gas phase completely excluded. We are indebted to Dr. D. K. C. MacDonald for help during the experiments.

J. B. Brown
K. Mendelssohn

Clarendon Laboratory,
Oxford.
Aug. 13.

[1] Daunt and Mendelssohn, *Proc. Roy. Soc.*, A, 170, 423 (1939); *Nature*, 143, 719 (1939); 157, 839 (1946).
[2] Allen and Misener, *Proc. Roy. Soc.*, A, 172, 467 (1939).
[3] Allen and Jones, *Nature*, 141, 243 (1938).

Electron Density in Meteor Trails

Contemporary studies of the radio echoes from meteors indicate that dense transient concentrations of electrons are produced by the meteors at heights of 90–120 km. above the earth's surface[1,2,3]. Eckersley[4] calculated the intensity of scattered radio waves by assuming that the electrons were produced in a small cloud, and Pierce[5] by assuming that the electrons were produced in a long column, of diameter *large* compared with the wave-length of the radio wave.

Recent experimental work on higher frequencies in the region of 60–70 Mc./s. has shown that the main radio echo is obtained only when the aerial beam is directed at right angles to the track of the meteor[1,2]. This effect can be explained if the ionization is in the form of a long column, of diameter *small* compared with the wave-length of the incident radio wave. The intensity of a radio wave scattered from such a long narrow column of ionization in the atmosphere, assuming that the electrons scatter coherently, has been calculated by Blackett and Lovell[6], and in terms of the parameters of the radio apparatus it can be shown[7] that if α is the number of electrons per cm. path formed by the meteor and ε is the power scattered back to the receiver when the aerial beam is directed at right angles to the direction of the trail, then

$$\alpha = \sqrt{24}\,\pi \left(\frac{mc^2}{e^2}\right) \frac{1}{G} \sqrt{\frac{\varepsilon R^3}{P\lambda^3}},$$

where (mc^2/e^2) is the inverse of the classical electron radius, G is power gain of transmitter and receiving aerials over a half-wave dipole (assumed the same), R is distance of meteor trail from the apparatus, P is peak transmitter power, λ is wave-length of apparatus.

The validity of this formula has recently been tested experimentally as regards the predicted variation of received power ε with λ for a given meteor trail. During the Perseid meteor shower of August 1947, simultaneous observations of radio echoes from the same meteor trail were made on frequencies of 72 and 36 Mc./s. and also on 72 and 46 Mc./s. The experiment on 72 and 36 Mc./s. was repeated during a continuous 24-hour watch on September 23–24. For each pair of coincident echoes R and α will be the same, and if G and P are the same for the two equipments, the formula predicts that the ratio of the received powers ε_1 and ε_2 on two wave-lengths λ_1 and λ_2 will be $\varepsilon_1/\varepsilon_2 = (\lambda_1/\lambda_2)^n$. In the actual experiment the quantity measured is the amplitude of the echo on the cathode ray tube display, which can be converted to equivalent voltage input at the aerial by appropriate calibration of the receiver. If the two observed voltages are v_1 and v_2, then

$$\frac{v_1}{v_2} = \sqrt{\frac{\varepsilon_1}{\varepsilon_2}} = \left(\frac{\lambda_1}{\lambda_2}\right)^n,$$

and the theory predicts that the exponent n is 1·5.

107 coincident pairs of echoes were measured with $\lambda_1 = 8{\cdot}3$ m., $\lambda_2 = 4{\cdot}15$ m., and 57 coincident pairs with $\lambda_1 = 6{\cdot}5$ m., $\lambda_2 = 4{\cdot}15$ m., between August 12 and 27. On September 23–24 a further 160 pairs were measured with $\lambda_1 = 8{\cdot}3$ m., $\lambda_2 = 4{\cdot}15$ m. From the measured values of v_1 and v_2, the exponent n has been calculated for each pair and the results are summarized in the accompanying table.

	Number of observations	Number of observations used in calculation	Ratio $\frac{\lambda_1}{\lambda_2}$	Mean value of measured voltage ratio $\left(\frac{v_1}{v_2}\right)$	Mean value of exponent n	Standard deviation
Aug. 12–27: Simultaneous observations on 36 and 72 Mc./s.	107	74	2·0	2·6	1·4	0·5
Simultaneous observations on 46 and 72 Mc./s.	57	38	1·56	2·2	1·8	0·5
Sept. 23–24: Simultaneous observations on 36 and 72 Mc./s.	160	135	2·0	2·4	1·3	0·5

The observed voltages v_1 and v_2 used in these results have been corrected for the differences in peak power P between the three equipments. The main error in the experiment lies in the assumption that the aerial gain G is the same. Although geometrically similar aerial systems were used on the three wave-lengths, slight differences of terrain and surroundings inevitably introduce variations in the polar diagrams of the aerials. It can therefore be anticipated that a certain number of meteor trails will form in regions where the polar diagrams of the two comparison equipments are not exactly similar, and hence give rise to a considerable scatter of the results about the mean value. In deriving the results given in the table, coincident pairs showing deviations from the mean exponent greater than three times the average deviation have been rejected.

The results are in reasonable agreement with the predicted relation between ε and λ, and although more experiments are needed to establish the exact relationships, it now seems plausible to assume that the fundamental assumptions made in deriving the formula are not seriously in error for radio wave frequencies in the 30–70 Mc./s. region.

By using this formula it is possible to calculate the electron density in meteor trails, since G, P and λ are constants of the apparatus and ε and R are measured for individual echoes. The densities measured (with $G = 4$, $P = 70$ kW., $\lambda = 4{\cdot}15$ m.) lie in the range 10^{10}–10^{13} electrons per centimetre of path. Triple simultaneous observations of meteors on the two equipments and visually were also made during this experiment. These results show that a 5th magnitude meteor which is near the limit of naked eye visibility produces about 2×10^{10} electrons per centimetre of path. These results for electron densities lie in the same region as those found by combined visual and radio echo measurements on the 1946 Perseid shower[2].

These experiments were made at the Jodrell Bank Experimental Station of the University of Manchester in conjunction with J. A. Clegg, J. G. Davies, C. D. Ellyett and V. A. Hughes.

A. C. B. Lovell

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Manchester.
Sept. 27.

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[4] Eckersley, *J. Inst. Elect. Eng.*, **71**, 405 (1932).
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A New Technique for Following the Attack of Metallic Mirrors by Free Radicals

THE removal of metallic mirrors is a well-established technique for the detection and identification of free radicals produced in the decomposition of organic compounds. The rate of removal of mirrors is usually followed by photometric means, in which the opacity of the mirror is matched against that of a standard. In the course of an investigation into the attack of free radicals on coal and coal by-products at high temperatures, it was found that the evolution of smoke and tarry material tended to make the use of optical methods somewhat unreliable. It was thought that measurement of the electrical conductivity of mirrors could be applied to the problem and, in particular, glass elements of the type used in the measurement of the dewpoint of combustion gases containing sulphur oxides[1] seemed to be ideal for this purpose.

The elements used have been described in detail by Dooley and Whittingham and consist of a 'Pyrex' tube closed at one end into which two platinum–platinum-rhodium thermocouples are fused. The convex surface is carefully polished so that the thermocouples lie correctly in the surface, and a known potential is applied across the gap, the current passing being measured on a micro-ammeter.

The temperature of the surface can be accurately recorded, and the deposition and removal of extremely thin metallic mirrors is reflected in changes in the electrical conductivity across the gap between the thermocouples. The use of this technique can best be illustrated by reference to some exploratory work carried out on the decomposition of lead tetraethyl.

The element was fitted with a ground-glass joint, to permit ease of removal, and was placed at one end of a long 'Pyrex' tube through which a rapid stream of oxygen-free nitrogen, at a pressure of 1–2 mm., was passed. The nitrogen was charged with lead tetra-ethyl vapour by passage through a trap, maintained at − 78° C., containing lead tetraethyl. The area of glass between the two thermocouples, approximately 0·5 sq. cm., was heated either by a small platinum spiral inserted inside the element, or by directing a stream of air through an electrically heated quartz tube on the underside of the element.

On heating the glass a slow increase in conductivity due to the production of a lead film was first observed at 180° C., and a more rapid build-up took place at 200–220° C. These temperatures are well below those at which the glass begins to exhibit conductivity. After the conductivity had increased to any desired value the source of heat was removed, and the element allowed to cool to room temperature. The tube through which the nitrogen – lead ethyl mixture passed was then heated at different distances from the element, and the accompanying table gives values obtained for the time of removal of the mirror (θ) at a distance d from the point at which the ethyl radicals are produced. The streaming velocity of the gases was 11 metres per sec. and the life of the radical (t) is therefore $d/1{,}100$ sec.

Distance, d, in cm.	Life, t, in sec.	Removal time, θ, in sec.	$\log_{10} 1/\theta$
4	$3{\cdot}6 \times 10^{-3}$	26	$\bar{2}{\cdot}5850$
8	$7{\cdot}2$	31	$\bar{2}{\cdot}5086$
12	$10{\cdot}9$	45	$\bar{2}{\cdot}3468$
18	$16{\cdot}4$	65	$\bar{2}{\cdot}1871$
28	$25{\cdot}4$	120	$\bar{3}{\cdot}9208$

From the plot of $\log_{10} 1/\theta$ against t the half-life period of the ethyl radicals was found to be $1{\cdot}4 \times 10^{-2}$ sec. No difficulty has been encountered either in depositing reproducible mirrors of a given thickness or in obtaining consistent times of removal.

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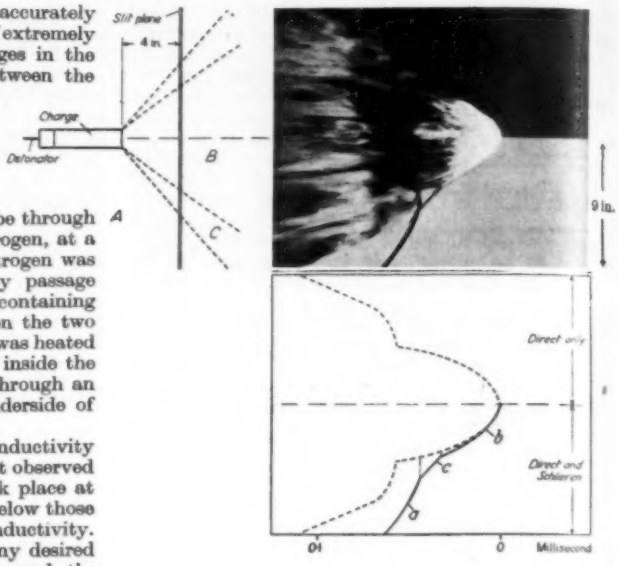
[1] Dooley, A., and Whittingham, G., *Trans. Farad. Soc.*, **42**, 354 (1946).

Mach Waves in Shock Wave Systems from Detonating Explosives

We have recently obtained many photographs of Mach waves[1], known alternatively as 'bridge' or 'Y' waves[2], in the shock wave systems resulting from the detonation of unconfined charges of solid explosive. Waves of this type, which Mach postulated from the observation of soot patterns, are produced when supersonic waves intersect at obtuse angles of incidence. Instead of the simple intersection (which obtains in collisions at acute angles as well as in collisions of sonic waves at any angle of incidence), there is formed a Mach wave which travels in a direction parallel to the plane of symmetry bisecting the angle between the original colliding shock waves.



The accompanying *Schlieren* photograph, taken with the Buxton rotating-mirror camera, depicts the development of the flame and shock wave system in a plane 4 in. beyond the end and at right angles to the axis of a right cylinder of cast 30 : 70–tetryl/T.N.T., $1\frac{1}{2}$ in. in diameter (velocity of detonation 7,030 m./sec.). The diagram to the left of the photograph indicates the position of the charge with respect to the camera slit. The lettered diagram below the record shows a lateral wave a, a terminal wave b and an intermediate wave c, all in full line; the broken line represents the boundary of the products of the detonation. Waves a and b arise in a way previously proposed[3], a during the passage of the detonation wave along the charge, and b from the detonation of the ultimate layers of explosive. The impulses are directed, one very nearly in the equatorial plane and the other along the axis; wave c is a Mach wave arising from the progressive collision of a and b at sufficiently oblique incidence.

From plottings of the linkage points of c with a and with b as measured on records of the shock wave system in different planes, curves can be derived which outline a widening annular region swept out by the Mach wave c. The section of this region is a funnel with smooth boundaries which curve towards the axis, the inner more so than the outer. The position of the funnel C is shown in the diagram to the left of the photograph, the regions marked A and B being those traversed by the waves a and b respectively. As expected, the funnel is generated from the circular periphery of the plane end of the explosive, and its initial direction coincides approximately with the external bisector of the angle between the two intersecting surfaces, that is, at about 45° to the axis in the simple case of the right cylinder. The shape of the Mach funnel and its direction depend, however, on the shape of the charge; for example, a circular Mach wave (as distinct from the

above annular type) is generated from the point of a cone, provided that the apical angle is less than about 135°. In similar fashion, it is found that Mach-type discontinuities link the lateral waves from adjacent surfaces of a square prism of explosive.

These photographic experiments have been carried out for the Ministry of Supply, and approval for the publication of this note has been given by the Chief Scientist.

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June 21.

[1] Mach, *Sitz. (Wiener) Akad. Wissenschaften*, 77, 819 (1878).
[2] McMillen and Harvey, *J. Appl. Phys.*, 17, 541 (1946).
[3] Payman and Woodhead, *Proc. Roy. Soc.*, A, 163, 575 (1937).

The 'Floating Thread', a Surface Phenomenon on Flowing Water

In 1936, W. Schmidt[1] described the following phenomenon. When the surface of slowly moving water encounters an obstacle (such as a stick put across a brook and upon its surface), a tiny elevation of the surface is formed at a distance of some decimetres or metres before the obstacle, "appearing like a very fine thread or hair floating on the surface". "Minute floating particles crossing the thread are abruptly retarded and thus accumulate." "That capillary forces are largely responsible for the phenomenon is proved by pouring a liquid of lower surface tension like liquid paraffin over the surface, when the thread is at once displaced upstream by several metres." Schmidt offers no detailed explanation of the phenomenon, and, so far as I know, nothing else was published about the matter.

The surface between the thread (which is perpendicular to the direction of flow) and the obstacle being motionless, the shearing force being in equilibrium with the gradient of surface tension:

$$\mu \left(\frac{\partial v_x}{\partial y}\right)_{y=0} + \frac{d\sigma}{dx} = 0$$

(where y is depth, and velocity of undisturbed flow is $(-v_0, 0)$). The solution of Oseen's equation for the flow along a rigid half-plane[2] gives an approximate formula for the shearing velocity:

$$\left(\frac{\partial v_x}{\partial y}\right)_{\substack{y=0 \\ x<0}} = -\sqrt{\frac{\rho v_0^3}{-\pi\mu x}}$$

(the half-plane covers the negative x-axis). Whereas the tension of the free-flowing part of the surface upstream of the thread ($x > 0$) has a constant value ($\sigma = \sigma_0$), on the downstream side the tension falls towards the obstacle:

$$\sigma = \sigma_0 - 2\sqrt{\frac{-\rho\mu v_0^3 x}{\pi}}.$$

Thus the distance (d) between the thread and the obstacle is determined with the minimum surface tension (σ_1) which can be attained with the present quantity of capillary-active substance:

$$d = \frac{x(\sigma_0 - \sigma_1)^2}{4\mu\rho v_0^3};$$

in the case of turbulence, that is, at $\rho v_0 d/\mu > 500{,}000$, the formula gives values which are too large.

The hydrodynamic problem was solved by assuming the surface to be plane. A constant value of the pressure (equal to the atmospheric pressure p_0) was found only at the downstream part of the surface, while at the upstream part the calculation gives the difference $p - p_0 = \sqrt{\frac{\rho\mu v_0^3}{\pi x}}$. An approximation for the real shape of the surface, $y = y(x)$, can be obtained by putting the calculated pressure-difference into the equation for the equilibrium between pressure-, gravity- and capillarity-forces:

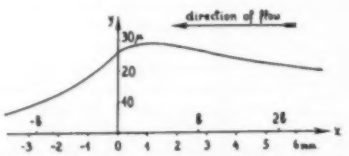
$$\sigma \frac{d^3y}{dx^3} - \rho g y = \begin{cases} 0 \ldots\ldots\ldots x < 0 \\ \sqrt{\frac{\rho\mu v_0^3}{\pi x}} \ldots\ldots x > 0 \end{cases}$$

y and dy/dx must both be continuous at $x = 0$, whereas d^2x/dx^2 becomes infinite at the upstream side. Neglecting now the inconstancy of the surface tension on the downstream side, we get the approximate result:

$$y = \frac{\lambda}{2g}\sqrt{\frac{\mu v_0^3}{\rho b}} \cdot \exp\frac{x}{b} \ldots\ldots x < 0.$$

$$y = \frac{\lambda}{2g}\sqrt{\frac{\mu v_0^3}{\rho b}} \cdot \frac{\lambda}{\sqrt{\pi}} \int_0^\infty \frac{\left(\exp - \left|\frac{x}{b} - \xi\right|\right)}{\sqrt{\xi}} d\xi \ldots\ldots x > 0.$$

The length $b = \sqrt{\sigma_0/\rho g}$ may serve as a measure of the width of the thread. The maximum elevation is at $x = 0{\cdot}40\,b$; $y_{max} = 1{\cdot}104 y(0)$.



Cross-section of the floating thread. The height is exaggerated 100 times

A numerical example (see figure) may give an idea of the size of the phenomenon. Take $\sigma_0 = 70$ dyne/cm., $\sigma_1 = 30$ dyne/cm., $\mu = 0{\cdot}01$ poise, $v_0 = 10$ cm./sec. It follows that $d = 126$ cm., $b = 0{\cdot}27$ cm., $y(0) = 0{\cdot}0026$ cm., $(dy/dx)_0 = 0{\cdot}01$ cm. Obviously the results justify the simplifications made above. Very rough preliminary observations seem to agree with the suggested theory (measurements are in progress). With a slight modification the same theory can help to describe the mechanism of spreading of capillary-active films on liquid surfaces, as first observed by Osborne Reynolds[3].

The discontinuity at the thread might seem to present a theoretical difficulty. The infinite curvature at $x = +0$ involves an infinite pressure below that point. Of course, the consideration of the diffusion of the capillary-active substance would have avoided that difficulty. But even without that, it is evident that large pressures do not appear at all; calculation shows that the interval in which the

pressure difference would be comparable with the atmospheric pressure is of molecular order of size or smaller.

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[1] Schmidt, W., *Nature*, **137**, 777 (1936).
[2] Compare with Lamb–Oseen's solution for the cylinder. See, for example, Müller, W., "Einführung in die Theorie der zähen Flüssigkeiten", 127 (Leipzig, 1932).
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Mechanical Degradation of Large Molecules

FROM the thermo-chemical data for the strength of the carbon-carbon single bond (about 5×10^{-3} dynes), the rate of shear was estimated for rupturing the centre bond of large hydrocarbon molecules in solution under laminar flow conditions owing to the component of the viscous drag in the direction of the long axis of the molecule. Experiments confirmed the calculated order of magnitude of the critical value of the rate of shear as a function of the chain-length of the molecule.

TABLE 1. PERCENTAGE PERMANENT VISCOSITY-LOSS AT 20° C. WITH THE NUMBER OF PASSAGES OF THE LIQUID THROUGH THE JET FOR A 5 PER CENT SOLUTION OF A POLYMER HAVING AN AVERAGE MOLECULAR WEIGHT ABOVE 100,000 WITH AN INITIAL MEAN RATE OF SHEAR OF $1{\cdot}75 \times 10^5$ SEC.$^{-1}$

Apparent percentage permanent viscosity loss from (pt)-values*	Number of cycles through jet	Percentage permanent viscosity loss at low rates of shear	Viscosity-temperature coefficient
0	0	0	− 1·770
4·8	6		
6·3	7		
6·3	8		
7·8	9		
7·8	11		
7·9	12		
8·2	13		
10·0	18		
10·6	25		
11·1	28		
11·1	29		
11·3	30		
13·7	56		
13·8	70		
15·0	71		
13·9	72		
15·2	102		
15·3	103	8·8	− 1·877

* p = pressure difference across jet in cm. mercury, t = time of flow in seconds. The permanent decrease of the (pt)-values of very long molecules (length of the order of 1 per cent of the diameter of the jet) is always larger than the permanent viscosity-loss measured at low rates of shear because turbulence arises with these long molecules even at very low Reynolds' numbers. With the degradation of the molecules this tendency to turbulence becomes reduced.

With an apparatus[1] giving mean rates of shear of the order of 10^5 sec.$^{-1}$ under laminar flow conditions, long-chain molecules of molecular weights above 100,000 were broken down (Table 1), yielding an exponential type of decay curve for the percentage permanent viscosity-loss plotted as a function of the number of cycles of forcing the solution in individual drops through a jet. The mechanical degradation was assessed by the *permanent* viscosity-loss of the solutions at low rates of shear, by the accompanying increase of the viscosity-temperature coefficient of the solutions and by the displacement of the transition region from laminar to turbulent flow towards higher values of the rate of shear as the result of rupturing the largest molecules.

According to the simplifying assumptions made for the calculations, the stretching forces reached their largest value for the centre chemical bond and would increase with the square of the length of the molecule for a given value of the shearing stress. Thus, rates of shear of more than $1{\cdot}6 \times 10^6$ sec.$^{-1}$ would be required for the breakdown of molecules of molecular weights of 25,000 and less.

TABLE 2. PERCENTAGE PERMANENT VISCOSITY-LOSS WITH THE NUMBER OF PASSAGES OF THE LIQUID THROUGH THE JET FOR A 5 PER CENT SOLUTION OF A POLYMER HAVING AN AVERAGE MOLECULAR WEIGHT LESS THAN 25,000

Mean rate of shear in sec.$^{-1}$	Percentage permanent viscosity loss at low rate of shear and at 37·8° C.	Number of cycles	Viscosity-temperature coefficient
0	0	0	− 2·813
$3{\cdot}823 \times 10^6$	3·4	500	− 2·846
$3{\cdot}823 \times 10^6$	7·0	2500	− 2·882
$3{\cdot}823 \times 10^6$	9·2	5000	− 2·907
$6{\cdot}324 \times 10^6$	6·0	1000	− 2·885
$6{\cdot}324 \times 10^6$	12·3	5000	− 2·954
1×10^7	8·0	2000	− 2·912
1×10^7	13·0	5000	− 2·979

With a high-pressure jet (to be described elsewhere) calculated to give rates of shear of the order of 10^7 sec.$^{-1}$ for Poiseuille flow, materials of molecular weights of 25,000 and less which remained unaffected in the previous apparatus[1] for rates of shear of the order of 10^6 sec.$^{-1}$ were broken down (Table 2).

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[1] Morris, W. J., and Schnurmann, R., *Rev. Sci. Instr.*, **17**, 17 (1946).

Christiansen Filters for the Ultra-Violet

Gaydon and Minkoff[1] have described a Christiansen filter designed to isolate the 2537 A. resonance line of mercury. We have been working for some time upon the general problem of the design of Christiansen filters for the isolation of various spark and discharge tube lines to be used in ultra-violet microscopy. We have amplified the work of Kohn and von Fragstein[2], and developed a series of filters employing benzene–alcohol mixtures with fused quartz chips, which can span the region 3000–4000 A.

The absorption of benzene prevents the use of this combination below 3000 A. Therefore, we have developed a set of filters employing mixtures of purified decahydronaphthalene and cyclohexane,

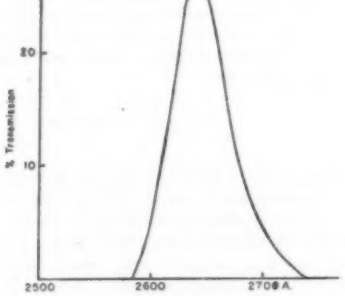

Fig. 1

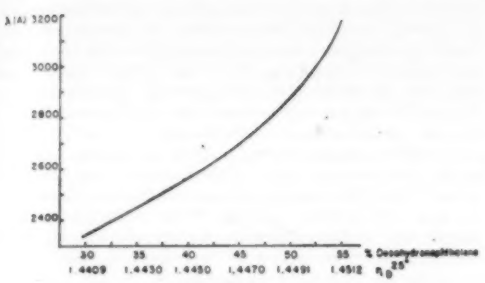

Fig. 2

which, with quartz chips, can be used in the region 2350–3000 A. The decahydronaphthalene and cyclohexane are purified by treatment with activated silica gel, either by passage through a column or by shaking with repeat charges. When thus purified, the cyclohexane in 1 cm. thickness will transmit, with a density less than 0·05, to 2250 A., the decahydronaphthalene to 2380 A.

A typical transmission curve for a filter designed to isolate the 2652 A. line of a medium-pressure mercury discharge tube is shown in Fig. 1. This filter employed quartz chips, graded between 0·6 and 0·8 mm., and was 5 cm. thick. The transmission curve was obtained on a small Hilger spectrograph. Fig. 2 indicates the composition of mixtures to provide filters giving a peak value at the wave-length indicated by the ordinate at 25° C. The $n_D^{25°}$ of the mixture is also given, as this is probably a more accurate indication of the correct mixture.

Above 3000 A., benzene–alcohol mixtures are to be preferred, as they provide filters of narrower bandwidth for the same thickness.

Studies are in progress as to the effect of particle size, optical parameters, etc., upon the peak transmission and band-width of these filters.

This work has been done in part under an American Cancer Society fellowship and grant recommended by the National Research Council Committee on Growth.

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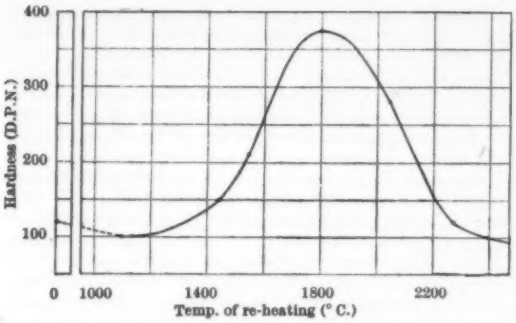
[1] Gaydon and Minkoff, *Nature*, **158**, 788 (1946).
[2] Kohn and von Fragstein, *Phys. Z.*, **33**, 929 (1932).

Annealing Temperature and Hardness of Tantalum

During experiments to determine the relationship between annealing temperature and hardness of tantalum after cold working, it was found that after a slight preliminary softening (temperatures up to 1,100° C.) the hardness rose steeply, reaching a maximum value after heating to 1,800° C., then falling again with higher temperatures.

The heating was carried out by passing a low-voltage current through the test piece in a vacuum of the order of 10^{-3}–10^{-4} mm. of mercury. When the current ceased to flow, the test piece cooled quickly by radiation. A typical curve is given in the accompanying figure.



The following points have been proved:

(*a*) Tantalum powder from three sources (American, Australian and German) compacted by pressing and sintering was cold worked (room temperature) by swaging and wire drawing and was quite ductile. On heating to 1,800° C. (as above) all materials became hard and brittle.

(*b*) The maximum value of hardness is found after heating to 1,800° C. irrespective of the initial amount of cold work.

(*c*) The hardness maximum appears to be a function of the initial amount of cold work, though no regular relationship has been found. The hardest material produced had a value 500 D.P.N.

(*d*) Hard tantalum becomes soft again if the heating is carried to 2,400° C. followed by quick cooling.

(*e*) Tantalum reheated to 2,400° C. and slowly cooled (7° C. per minute) to 1,100° C. is hard and brittle.

(*f*) X-ray diffraction patterns from tantalum in the soft and hard states indicate a body cubic structure in both cases. However, in the soft condition the lines are composed of distinct sharp spots, whereas in the hard state the lines are diffuse, and broader, and the spacing indicates an expanded lattice. No new lines were visible.

The most reasonable explanation of the above facts would appear to be that some gas molecules are absorbed even at the low pressure stated, and that these are held most tenaciously at 1,800° C. The increase in hardness of 300–400 units D.P.N. for such relatively low concentrations is, however, remarkable. The phenomenon is being further investigated.

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Tryptophane as Precursor of Nicotinamide in Mammals

Tryptophane can replace nicotinamide in the nutrition of the growing rat[1] and when ingested increases the urinary elimination of nicotinamide derivatives of mammals and man[2–6]. The site and mechanism of this conversion of tryptophane into nicotinamide are unknown and form the subject of this investigation.

Biosynthesis of nicotinamide may occur in the mammalian tissue[7] or in the intestinal flora[8–12]. Bacteria of the *coli* type seem to be mainly responsible for the synthesis[13,14]. To find out whether the tryptophane conversion takes place in the tissues or

the intestinal flora, rats kept on a mixed diet received 100 mgm. of *d,l*-tryptophane at three-day intervals alternatively either orally or parenterally. The increase in urinary nicotinamide methochloride elimination proved to be two to five times greater after oral than after parenteral administration, which is in accordance with findings of Schweigert and Pearson[3]. In other rats similarly fed, the increase in urinary nicotinamide methochloride output following tryptophane ingestion was measured before and during the daily administration of 1 gm. succinylsulphathiazole, with simultaneous bacteriological control of the fæces. When the fæcal *coli* and the spontaneous nicotinamide methochloride output were considerably reduced the increase in nicotinamide methochloride elimination caused by 100 mgm. of *d,l*-tryptophane was reduced to a fifth to a half the original increase. The results of both groups of experiments demonstrate at least that the intestinal flora is involved in the tryptophane conversion.

Of the known metabolites of tryptophane, kynurenic acid[15], kynurenine[16] and xanthurenic acid[17], none is a probable precursor of nicotinamide, because the first is an α-carboxylic acid, and nicotinic acid is a β-carboxylic acid, and the two others are only sparingly formed in the non-deficient animal. The urinary output of nicotinamide derivatives could not be increased by the ingestion of kynurenic acid[18]. Only 25–30 per cent of ingested tryptophane is eliminated as these metabolites.

When considering another possible way of degradation, we thought of the hitherto unproved formation of ornithine by reductive splitting off of the pyrrole nucleus. Ornithine was suggested as basis of the biosynthesis of nicotinic acid by Guggenheim[19].

To investigate this question, 24-hr. cultures of two *coli* strains isolated from rat fæces and known to synthesize nicotinamide when grown in an ammonium lactate medium[20] were inoculated and grown in this medium containing various concentrations of the following amino-acids: *l*(+) ornithine, *l*(+) arginine, *d,l*-glutamine, *d,l*-glutamic acid, *l*(+) citrulline, *l*(+) proline, *l*(+) leucine, *l*(−) isoleucine, *d,l*-valine, and *d,l*-tryptophane. Concentrations of *M*/1,500 to *M*/1,000 of the amino-acids proved to be most efficient. After 24 hr. incubation, the cultures were autoclaved and the growth assayed by titrating the acid formed with *N*/10 sodium hydroxide. Nicotinamide formed was measured microbiologically using *Lactobacillus arabinosus* in Barton-Wright[21] medium as a test object. Controls showed that none of the amino-acids used affected the acid formation by *Lactobacillus arabinosus*. The growth was increased by about 30–70 per cent by leucine, isoleucine, valine, citrulline, glutamic acid and tryptophane, but not, or less than 10 per cent, by the others. The formation of nicotinamide was, however, increased up to 4½ times by ornithine, by 50–70 per cent by glutamine and arginine when compared with the synthesis of nicotinamide in the controls. Of the other amino-acids, proline and tryptophane did not affect the relative nicotinamide production, while the others inhibited it. By a simultaneous assay using a *Leuconostoc mesenteroides* strain (kindly supplied by Dr. B. C. Johnson of the University of Illinois) which was much less sensitive to nicotinamide than to nicotinic acid, it was found that the derivative formed by the *coli* was almost exclusively nicotinamide.

These results show that ornithine can be utilized *in vitro* for the biosynthesis of nicotinamide by *coli*, and that arginine and glutamine, also with amino-groups in the δ-position and which probably can be converted into ornithine, have a similar effect. Whether ornithine can be formed from tryptophane has still to be proved. The fact that tryptophane does not increase the nicotinamide production by *coli* under the conditions of the experiment might be due to the inability of the *coli* to perform the tryptophane degradation. Other intestinal bacteria might be able to do this. Experiments using a mixed culture from the contents of a rat's cæcum showed an increase of nicotinamide production when tryptophane was added. This needs further investigation.

Ingestion of ornithine by rats did not increase the nicotinamide methochloride output, which might be explained by the quick utilization of this compound for protein formation. Perhaps the use of some possible intermediary between ornithine and nicotinamide may elucidate this point.

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Composition and Structure of the Liver Cell in Pregnancy

It has been previously shown that the deoxyribonucleic acid content of the liver is independent of the protein content of the diet, while the protein, phospholipin and ribonucleic acid contents vary directly with the dietary protein intake[1].

Little is known regarding the changes occurring in the liver during pregnancy. Liver proteins are increased and more of the maternal protein is apportioned to the liver in pregnant rats than in non-pregnant controls[2]. The total nucleic acid content is considerably increased, both deoxyribonucleic acid and ribonucleic acid taking part in this rise[3].

It has now been found that in pregnant rats, during the third week of gestation, the deoxyribonucleic acid content of the liver (mgm. per liver) is con-

siderably raised. Since the deoxyribonucleic acid content of the liver rises with increasing body weight, the changes in body weight during pregnancy have to be taken into account. The statistical analysis of the data (Dr. J. O. Irwin) shows that when adjusted for differences in maternal body weight (without fœtuses), the deoxyribonucleic acid content of the liver is significantly greater in pregnant than in non-pregnant rats, and, further, that the total quantity of deoxyribonucleic acid found in the liver during pregnancy closely corresponds to the sum of the maternal and fœtal body weights. This would signify that in pregnancy the liver has to fulfil its metabolic functions not only for the maternal body but also for the fœtuses. The rise in liver deoxyribonucleic acid is found in rats fed on the stock diet (group *A*), and in rats which had been fed on a protein-free diet for five days prior to the examination of the liver (group *B*).

The most remarkable of the changes occurring in the liver during pregnancy is, however, the rise in the ratio of ribonucleic to deoxyribonucleic acid. We found that this increased from 3·97 to 5·81 in group *A* (+46·5 per cent) and from 3·17 to 4·42 in group *B* (+ 39·5 per cent). It is known[1] that the changes in the ratio of ribonucleic to deoxyribonucleic acid due to variations in the dietary protein intake are accompanied by corresponding changes of approximately the same magnitude in the protein to deoxyribonucleic acid and phospholipin to deoxyribonucleic acid ratios. This also is true for pregnant rats; but in addition to the dietary variations of all three ratios, there is in pregnancy a specific rise in the ratio of ribonucleic to deoxyribonucleic acid, with inconsistent and relatively small changes in the other two ratios. Thus in group *A*, the protein to deoxyribonucleic acid ratio of the pregnant rats was only 9 per cent higher than that of the non-pregnant controls, while the phospholipin to deoxyribonucleic acid ratio did not change significantly; in group *B* there was no significant change in the protein to deoxyribonucleic acid ratio, while the phospholipin to deoxyribonucleic acid ratio rose by 21 per cent in the pregnant rats. The magnitude of the rise of the ratio of ribonucleic to deoxyribonucleic acid above the values found in non-pregnant controls is positively correlated with the weight of the uterine contents.

The presence of these large amounts of ribonucleic acid in the liver cell during pregnancy has its histological counterpart in a great increase in cytoplasmic basophilia. This is particularly well seen as diffuse basophilia in the periportal area and, by means of Brachet's ribonuclease test, has been proved to be caused by ribonucleic acid.

The glycogen content of the livers in both dietary groups is very much decreased during pregnancy.

We wish to thank Dr. J. O. Irwin, who kindly carried out the statistical analysis of the deoxyribonucleic acid data. We are also indebted to the Medical Research Council for grants for scientific assistance and expenses (to H. W. K.).

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Fluorescent Constituents of Liver Lipid Extracts

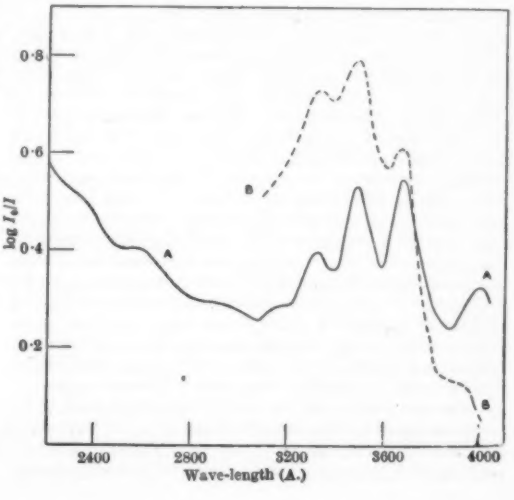
Penn and Kaplan[1] recently reported the preparation of concentrates exhibiting banded fluorescence spectra from acetone extracts of the livers of cancer patients. They have directed attention to the similarity between these spectra and the fluorescence spectrum of methylcholanthrene.

In continuation of earlier work[2], we have concentrated the fluorescent constituents of the non-saponifiable lipid-soluble material obtained from the livers of five cancerous and two non-cancerous individuals; but in none of our fractions have we been able to recognize any polynuclear aromatic hydrocarbons by ultra-violet spectrophotometry.

From two of the livers, fractions were obtained which possessed sharply banded absorption spectra between 3000 and 4000 A., and which exhibited an intense bluish-green fluorescence. The spectrum of one such fraction (Curve *A*) gave strong maxima at 3320, 3480 and 3680 A. in solution in *n*-heptane, together with a weaker maximum at 3990 A. The absence of intense absorption between 2000 and 3000 A. in curve *A* makes it improbable that these bands are associated with the presence of a condensed polynuclear aromatic hydrocarbon in the extract. The spectrum between 3200 and 3800 A. is closely similar to that reported by Zechmeister and Polgár[3] for material isolated from several plant sources, and tentatively identified by these investigators as iso-anhydro-vitamin A; the band at 3990 A. may be due to anhydro-vitamin A [4].

Iso-anhydro-vitamin A, prepared in our laboratory by the prolonged action of dry hydrogen chloride on a chloroform solution of vitamin A, gave the spectrum shown in Curve *B*, the location of the maxima being in good accord with those reported by Shantz, Cawley and Embree[4]. This product also exhibited a greenish-blue fluorescence, more stable and much more intense than that of vitamin A. Mixed with one of the fluorescent liver concentrates, it yielded a single fluorescent zone when adsorbed from hexane on a column of activated alumina.

These results indicate that at least part of the fluorescing material in the non-saponifiable fractions of liver lipids is probably associated closely with



vitamin A, although it is not clear whether the compound occurs in the liver as such or arises as a transformation product of vitamin A during the saponification and isolation process. The work of Edisbury and co-workers[5] on fish liver oils would suggest the latter may be the case.

Our concentrates were obtained by processes of solvent extraction, saponification, chromatographic adsorption and molecular distillation which will be described in detail elsewhere and which parallel quite closely those employed by Penn and Kaplan. The relationships between ultra-violet absorption spectra and fluorescence spectra are still not well understood; but the presence of fine structure in the near ultra-violet absorption of these fluorescing concentrates suggests the possibility that the banded fluorescent spectrum observed by Penn and Kaplan might have arisen from a similar substance.

The carcinogenic action of these liver extracts was negative when tested by subcutaneous injection in tricaprylin solution in mice. Since these extracts were essentially free from sterol, these observations do not contradict the findings of Hieger[6] concerning the carcinogenic activity of cholesterol fractions from similar source material.

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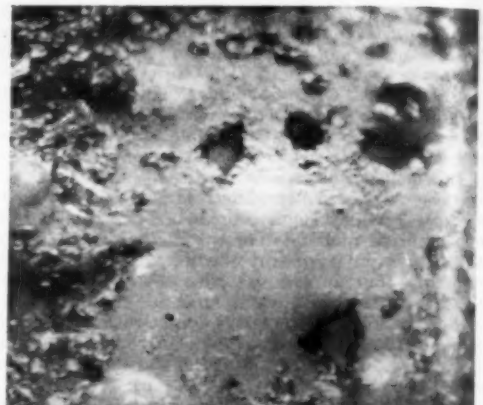
Tensile Stress as a Factor in Fern Phyllotaxis

Anatomical investigations of the development of leaf primordia in the broad shield fern (*Dryopteris aristata* Druce)[1,2] have led me to the view that during growth each primordium sets up tangential tensile stress in the apical meristem above its axil. A further hypothesis is that the next primordium to be formed arises in that region of the apical cone in which tensile stress is minimal. It has been observed that meristematic tissue in regions subjected to tensile stress typically develops into parenchyma.

In his "Allgemeine Morphologie der Gewachse" (1868, p. 508), Hofmeister has advanced a hypothesis on the same general lines. He has suggested: (1) that the outer walls of the superficial cells of the shoot apex offer resistance to the lateral outgrowth of new organs (primordia); (2) that this resistance is not uniform over the growing point, new lateral organs appearing in regions of greatest elasticity; (3) that in proximity to the last formed primordia the superficial membrane, being already stretched, has minimal elasticity; (4) that a new primordium will appear in that position on the apex which lies farthest from the last formed primordia, that is, in the position of maximal elasticity and minimal tension. While Hofmeister's observation that new leaf primordia arise in the largest gap has been accepted by many investigators of phyllotaxis, his mechanical theory outlined above has received little support.

Already Snow and Snow[3,4] have shown that if the vegetative apex of several different flowering plants is incised, either transversely or longitudinally, the cuts typically gape. They have used this information to refute the view of Schuepp[5,6] and Priestley[7] that there is more rapid growth of the superficial than the internal tissue at the apex and hence that leaves arise as a result of compressive stress; but they have not directly suggested that the presence of tensile stress in the apical meristem may be a factor determining phyllotaxis (in conjunction with other factors).



Downward view of the shoot apex of *Dryopteris aristata*. The circular puncture (top centre) is in the position of the next leaf primordium to be formed. The puncture in the axils of the primordia (top left and right) are distended tangentially, as is also that of the primordium (bottom right) below. (× 40) (Photo. by Ernest Ashby)

Preliminary studies of the distribution of growth in *D. aristata*, in specimens in which the apical region had been covered with a thin layer of lamp-black (applied as a suspension in 10 per cent gum arabic), support the hypotheses now advanced. Furthermore, when apices were laid bare and incised or punctured in different regions, positive evidence was obtained of the existence of tensile stress in and above the axil of each primordium, whereas stress was slight or absent in those regions in which the new primordia would arise (see accompanying photograph). The largest unoccupied space on the apical cone above the level of the last formed primordium, which, as Snow and Snow have pointed out, is the position in which the next leaf primordium will arise, is also that region of the apical meristem in which tensile stress is minimal. Why the imposition of tensile stress should affect the further development of the distinctive meristematic tissue at the shoot apex of ferns as it does is still obscure. The problem is an interesting one: its solution may be of considerable importance to our knowledge of morphogenetic processes.

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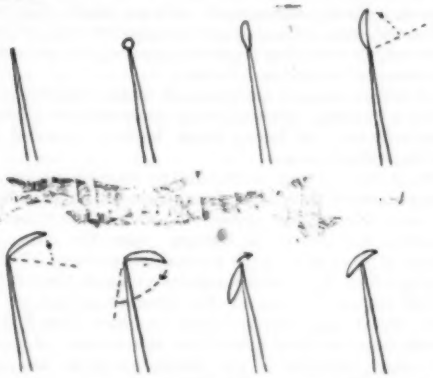
Passive Movements of Newly Formed Acrogenous Spores in *Verticillium* and Some Other Genera of the Hyphomycete Fungi

THE development of the spores in two species of *Verticillium*, namely, *V. Malthousei* Ware and *V. psalliotæ* Treschow, both parasitic on the cultivated mushroom *Psalliota* sp., was reported by Treschow[1] to be different. He observed the spores of *V. psalliotæ* lying transversely across the tips of the phialides on which they were developed. He concluded from this observation that the spores, which originated as a minute globule, grew out on either side perpendicular to the long axis of the phialide. He did not observe this transverse arrangement in *V. Malthousei* Ware, and neither did Ware[2] himself. It was, however, recorded in illustrations of this fungus by Atkins and Bulloch[3]. My own observations from time to time confirmed this record. More recently, I decided to compare the development of the spores in both these species under similar conditions, by continuous observation, using a moist chamber placed on slide cultures.



SEQUENCE OF EVENTS OCCURRING DURING SPORE DEVELOPMENT IN *Verticillium psalliotæ* TRESCH. (DIAGRAMMATIC)

In both *V. Malthousei* and *V. psalliotæ* the spores develop similarly. They appear first as a globule at the tip of the phialide and then elongate, usually in the long axis of the phialide, but sometimes obliquely until they attain approximately their full size and shape and contain a central vacuole. Spore development up to this stage lasts about one hour. The spore then tilts over gradually to form with the long axis of the phialide an angle of about 120°. Eventually, it continues to tilt, but more rapidly, sometimes even suddenly, to an angle of 90° or less. Then, after a short interval, while remaining in the plane perpendicular to the long axis of the phialide, it suddenly describes an arc through an angle of 90°, but sometimes 180°, and then almost immediately slips across the tip of the phialide to lie in the transverse position recorded by Treschow for *V. psalliotæ* and by Atkins and Bulloch in their illustrations of sporing phialides of *V. Malthousei*. In agreement with these various authors, I observed that in *V. Malthousei* many spores developed in succession at the tip of the same phialide, the first formed becoming levered out of its horizontal position by the second spore, which followed later. These spores remained clustered together in a drop of fluid. In the case of *V. psalliotæ* I have not so far observed the formation of more than one spore at the tip of each phialide, except in an isolated instance where two were formed in succession.

These spore movements which I have described for two species of *Verticillium* explain the misinterpretation by Treschow of the transverse position of the spore relative to the phialide in *V. psalliotæ* and the uninterpreted illustrations of *V. Malthousei* by Atkins and Bulloch.

From preliminary observations of spore development in some other genera of Hyphomycetes bearing non-pedicellate spores, notably *Cylindrocarpon*, *Fusarium* and the *Clonostachys* form of *Gliocladium*, it seems that movements of a similar nature and occurring in the same sequence are not confined to the genus *Verticillium* but probably occur in many other genera. I have, however, observed movements of a different nature often occurring in *Cylindrocarpon* and in *Fusarium* as an alternative to those I have described.

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Regulation of the Sodium–Potassium Ratio in Insects

THE variability of the sodium–potassium ratio in the cœlomic fluid of different species of insects and its association with the normal diet has been pointed out in previous papers[1,2]: the vegetarians having a high potassium concentration, the carnivorous insects a high sodium concentration in their cœlomic fluid.

In order to ascertain the nature of this association, the following hypotheses were tested: (1) The sodium–potassium ratio of the food might have a direct influence on the composition of the cœlomic fluid through lack of regulatory mechanisms in the insects. This possibility was suggested by the similarity between the sodium–potassium ratio of the cœlomic fluid and that of the diet; thus it is greater than 1 in the carnivorous insects and in animal fluids, less than 1 in vegetarian insects and in plant cells and saps. Carnivorous insect (*Calliphora erythrocephala*) and vegetarian insects (*Ephestia Kühniella*, *Pieris rapæ* and *Vanessa urticæ*) were raised from young to full-grown larvæ on diets with modified sodium–potassium ratio, all other factors being equal. This was done either by dialysing meat and wheat flour against solutions of various ionic

TABLE 1. Na/K REGULATION IN THE CŒLOMIC FLUID OF INSECTS

Insects and diets	Ions concentration in equiv./kgm.			
	In the diet		In cœlomic fluid	
	Na	K	Na	K
Calliphora erythrocephala (6 days on dialysed meat)	0·082 0·010	0·007 0·111	0·158 0·083	0·037 0·040
Ephestia Kühniella (35 days on dialysed flour)	0·098 0·098 0·008 0·008	0·011 0·011 0·115 0·115	0·030 0·027 0·016 —	0·047 0·056 0·059 0·065
Pieris rapæ (5 days on cabbage)	0·006 0·006 0·027 0·027	0·077 0·077 0·061 0·061	0·010 0·013 0·009 0·010	0·075 0·074 0·080 0·077
Vanessa urticæ, 2 days on:				
Leaves	0·010	0·100	0·022	0·043
Leaves coated with NaCl	0·366	0·088	0·058	0·049
Leaves coated with KCl	0·010	0·700	0·021	0·080

ratios, or by cultivating cabbages on coastal and inland soils, and also by coating leaves with salt solutions.

From the results (Table 1), a regulatory mechanism capable of dealing with the ionic composition of both diets is therefore undoubtedly present in insects.

(2) Unsuspected constituents of the diet might have an influence on the regulatory mechanisms; this eventuality was studied by raising the same insect, *Tenebrio molitor*, on a vegetable diet (cabbage and flour) or on a powdered meat diet. After 3½ months, the sodium and potassium concentration in the cœlomic fluid of the two batches was unaffected, as shown in Table 2.

TABLE 2. INFLUENCE OF THE DIET ON THE CŒLOMIC FLUID COMPOSITION OF *Tenebrio molitor*

Diet (during 3½ months)	Ions concentration in equiv./l.	
	Na	K
Cabbage + wheat flour	0·091 0·090	0·040 0·042
Meat	0·097 0·096	0·042 0·042

From these experiments, we may conclude that the association observed between the sodium–potassium ratio in the cœlomic fluid and the diet is not the result of the chemical composition of the foodstuff acting during the actual life of a given insect. The ionic composition of the internal medium, as found now, is a species characteristic, maintained by mechanisms of mineral regulation.

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Chick Embryos Surviving the Inoculation of an Equine Strain of Encephalomyelitis Virus

DURING routine work for the preparation on a big scale of embryo chick vaccine against equine encephalomyelitis, we observed that of 400 chick embryos 10–11 days old, inoculated with 0·05 ml. of a 20 per cent suspension of the infective brain tissue of guinea pig, there were sixty surviving embryos which continued development without inconvenience, judging by the trans-illumination control. Afterwards, and with the object of avoiding this effect, precautions were adopted to obtain the maximum mortality figures. Again, 400 chick embryos, 10–11 days old, were used and inoculated with the same virus strain with a dose of 0·1 ml. of a 30 per cent suspension of infective brain tissue of guinea pig taken from animals in the agonic period of the experimental encephalomyelitic infection. The effect was repeated, and about 10 per cent of the inoculated embryos behaved apparently like refractory animals, producing in due course well-shaped chicks.

In six other experiments, where 2,000 chick embryos, 9–12 days old, were used, it was found that if the experimental conditions were not changed, there were always chick embryos which, although having been duly inoculated, did not appear to be affected in their vitality after having received extraordinary amounts of active virus.

Further, experiments were also made, not only to check the observations, but also to study the possible influence of the age of the chick embryo, as well as the concentration of the virus at the dose used.

In all experiments we used a strain of virus of the encephalomyelitis equine West type maintained by passages in guinea pigs of 350–400 gm. weight, every 30 days, exclusively by the intralingual route.

Starting from brains extracted from guinea pigs in the agonic period, that is to say, 4½–5 days after inoculation, we made suspensions in buffer solutions at 7·2 *p*H with previous trituration and centrifugation of the infectious tissues. We chose, during the last assay, the dilution 10^{-1} at a dose of 0·1 ml. by the intra-alantoides route. This dose represents, on the basis of calculations made according to the recommendation of Reed and Muench[1], 500 L.D. (50) for guinea pigs by the intralingual route and 50 L.D. (50) for mice 28–30 days old by the intra-abdominal route; this last calculation is subject to the considerations quoted by Sabin and Olitsky[2] and Olitsky and Harford[3]. The age of the embryos we used was carefully controlled, and adequate controls were used for the inoculation technique, as well as for the maintenance of the chosen dose in contact with the embryonic tissues. Every inoculated embryo which died was extracted, and with previous trituration and dilution, inoculations into virgin guinea pigs and mice produced the encephalomyelitic infection.

Of 166 inoculated embryos, 22 which survived were tested and many of them born, presenting in all cases good vitality 96 hours after having received the corresponding doses.

Summing up our accumulated experience on the special behaviour of this virus strain of the encephalomyelitis equine West type, it is proved that it was not possible to obtain a regular mortality in chick embryos inoculated with a considerable dose of virus, and, further, that chick embryos younger than 9 days perish regularly due to the mortal action of the virus strain employed. Embryos older than 8 days, which have resisted alive the inoculation of a concentrated dilution of the strain studied, are comparatively less susceptible than guinea pigs and mice.

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Nephrotoxic and Renotropic Effects of Lead on White Rats and its Prevention by *B.A.L.*

THERE have been many studies on renal injuries produced by lead, but so far as we are aware, mention has never been made of a renotropic effect of lead.

Daily administration to white rats of 2 c.c. of a 4·5 per cent lead acetate solution by stomach tube produced an increase of weight in the kidneys, which was already appreciable at the ninth day and persisted in rats poisoned throughout periods of three, five and twelve months (see table). No changes in blood pressure were observed throughout the experiments. Controls received 2 c.c. of a 4·5 per cent sodium acetate solution. Microscopic study of the kidneys of lead-treated animals showed degenerative lesions in the cells of Henle's loop and simultaneously signs of intense regeneration with large anomalous nuclei.

EFFECTS OF LEAD ACETATE ON THE WEIGHT OF THE KIDNEYS OF FEMALE WHITE RATS, CALCULATED PER 100 CM.² OF BODY SURFACE

Treatment	Duration of experiment (days)	Number of animals	Body-weight, average (gm.)	Kidneys weight, average (gm./100 cm.²)
Lead treated	9	10	114 ± 4·7*	0·552 ± 0·019*
Controls	9	10	128 ± 5·4	0·395 ± 0·012
Lead treated	150	8	181 ± 6·5	0·499 ± 0·016
Controls	150	5	196 ± 12·0	0·367 ± 0·012
Lead treated	365	7	190 ± 11·2	0·653 ± 0·037
Uninephrectomy. Proteins and NaCl lead	90	6	175 ± 8·8	0·512 ± 0·023
Uninephrectomy. Proteins and NaCl.	90	4	191 ± 9·9	0·398 ± 0·023

* Standard error.

Hypophysectomy or adrenalectomy did not prevent the increase of weight and renal injury when lead salt solution was given to rats for a period of ten days.

Uninephrectomized rats fed on a standard diet and given lead for a period of six months had a tubular mass, as determined by diodrast excretion, 25 per cent greater than that of normal animals with both kidneys. Uninephrectomized controls on the same diet, but without lead, had a tubular mass 20 per cent below that of normal rats[1]. Uninephrectomized rats fed a diet rich in protein and sodium chloride and treated with lead throughout a period of three months had the same degree of hypertrophy of the tubular mass as those treated with lead and fed a standard diet.

The increase of kidney weight produced by giving the 4·5 per cent lead solution during ten days was almost completely prevented by injecting intraperitoneally twice daily 33 mgm. per kgm. of body-weight of a 2–3 dimercaptopropanol (*B.A.L.*) solution in distilled water. Microscopic study confirmed the results of the macroscopic observations.

It is worth mentioning that *B.A.L.* did not prevent the anæmia of lead poisoning in this species.

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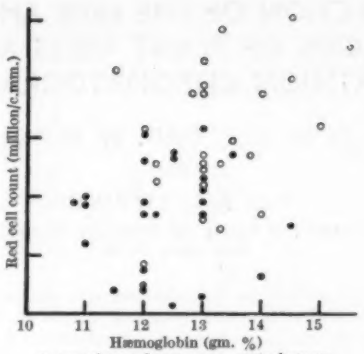
Induced Polycythæmia by *l*-Ascorbic Acid in Albino Mice

THE effect of *l*-ascorbic acid in increasing the number of red blood corpuscles has been studied in various laboratory animals[1] but hitherto not in mice. The present investigation was made to ascertain the action of the vitamin on the latter animal, taking into consideration, at the same time, the fact that there are many dietetic factors which affect the blood picture. Thus besides being properly fed on a diet consisting of cabbage and a mixture of cereal flour (8 parts) and whole milk powder (2 parts), the animals were given a salt mixture of iron, copper and cobalt (42, 55, 0·03 p.p.m. respectively[2]) and cod liver oil.

The animals, all male, were procured from the market and kept in the laboratory for one month before the experiment. Half received ascorbic acid and half served as control. Each mouse in the experimental group was fed daily 0·5 c.c. of a 4 per cent vitamin solution with a tuberculin syringe. The solution was prepared afresh every day. At the end of the third week, blood samples were taken from the tails of the animals. The red cell count was made with a Neubauer counting chamber after dilution with Hayem's solution. For hæmoglobin determination, the colorimetric acid-hæmatin method was employed.



○, experimental group; ●, control group

EFFECT OF ASCORBIC ACID ON MEAN RED CELL COUNT AND HÆMOGLOBIN VALUE OF MALE ALBINO MICE

Duration of experiment, 3 weeks. Number of mice in each group, 25. Ascorbic acid fed to experimental group, 2 mgm./mouse/day

	Average initial body wt. (gm.)	Average final body wt. (gm.)	Mean red cell count (million/c.mm.)	Mean hæmoglobin (gm. per cent)
Control group	15·1 ± 0·30	20·4 ± 0·36	9·70 ± 0·124	12·36 ± 0·125
Experimental group	15·2 ± 0·35	19·2 ± 0·39	11·12 ± 0·143	13·25 ± 0·132
Difference			1·42 5·07	0·89 3·59

The results, as summarized in the accompanying table, show that there is a general increase in the average body weight and that the mean red cell count and hæmoglobin value of the 25 mice in the experimental group are higher than those of animals in the control group. When the values of the red cell count and hæmoglobin are presented simultaneously in a graph, the points for the two groups can be seen to have different centres of distribution. The significance of the data, however, was clearly shown by treating them statistically. By the *t*-value method[3], the probability that the difference is due to chance is found to be 0·001 in the case of hæmoglobin value and less than 0·001 in that of the red count.

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DETECTION OF THE FREE AMINO-ACIDS OF PLANT CELLS BY PARTITION CHROMATOGRAPHY

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AND

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ACCORDING to the classical and perhaps most generally accepted theory of protein synthesis in plants the amino-acids are intermediates in a process which proceeds after the pattern first outlined by Emil Fischer in the well-known polypeptide theory. On other views the amino-acids are regarded rather as the products of protein hydrolysis and as the form in which soluble nitrogen may be stored and eventually mobilized when synthesis proceeds[1]. Whichever of these views is held, it is a commonplace that free amino-acids are widespread in plants and they are known to exist dissolved in the cell sap, to which they contribute part of the buffering properties which titration curves reveal. This is neither the place nor the occasion to give the number of free amino-acids which have been identified in plant materials.

The application of the technique of partition chromatography on paper, devised originally by Consden, Gordon and Martin[2], to the investigation of the soluble nitrogen components of plants is a natural development particularly in view of the further reports of its successful applications in animal biology[3–6]. It is also of interest that a similar technique has been applied to other compounds such as sugars[7].

A note[8] in *Nature* by LaCour and Drew reports, apparently for the first time, the use of this technique on plant material and therefore calls for some special comment.

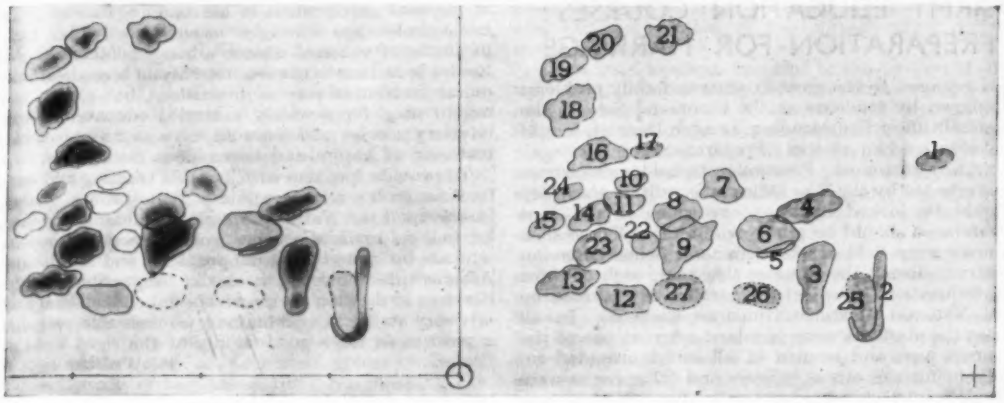
LaCour and Drew examined two types of plant materials: root-tips of *Trillium* and anthers of *Tradescantia* at various stages of development. The tissue was applied to filter paper strips in the form of a smear and the amino-acids were made to pass along the paper strip in phenol saturated with water, in accordance with the 'strip' or 'one-dimensional' technique familiar to users of the paper chromatographic method. On development of the chromatogram with the ninhydrin reagent LaCour and Drew obtained "two or more coloured bands indicating the presence of two or more free amino-acids".

It would indeed be somewhat surprising if plant cells contained as few amino-acids as suggested by the phrase "two or more". Although LaCour and Drew imply some casual relation between "nuclear activity" and the presence of amino-acids, their paper only allows one to conclude that two or more unidentified amino-acids are present in the crushed cells of *Trillium* root tips and the crushed anthers of *Tradescantia*. We therefore find it desirable to report the results of our own use of the paper chromatographic technique in the analysis of plant material. We do this, in advance of the publication of fuller details elsewhere, to show now the possibilities inherent in the method and also the biochemical range which studies of this kind involve.

The tissue at a cut potato surface is known to be capable of rapid metabolism in which protein synthesis from stored reserves of soluble nitrogen is a salient feature[1,9]. In moist air this tissue undergoes a recrudescence of growth which culminates in cell division and the formation of a meristem. In the form of thin disks (0·6 mm. or thinner) the tissues will accumulate salts from dilute solution and, without any inactive core of cells, will show evidence of great metabolic activity. We regarded, therefore, the potato tuber as particularly favourable material to study; first because the tissue is known to be rich in soluble nitrogen compounds, approximately two-thirds of the total nitrogen being soluble in alcohol; secondly, because of its known ability, under specified conditions, to synthesize protein at the expense of these reserves; thirdly, because of the known ability of the cells to grow and divide[10].

Briefly, we have established the following facts. The basic technique of paper chromatography is applicable to extracts of the soluble nitrogen of potato tissue under conditions which we shall specify exactly in a later communication. The amino-acids are best extracted in cold 70–80 per cent alcohol, giving a protein-free solution. The alcohol extracts are evaporated to dryness under reduced pressure without the use of heat and then are redissolved in water to give a solution which contains 10 mgm. of nitrogen per ml. For the chromatography an aliquot of extract containing approximately 50 μgm. of nitrogen (that is, 5 μl. of the solution) is normally used. The amino-acids on the paper square move for approximately thirty hours in phenol saturated with water, then the paper is dried. Afterwards the amino-acids move for approximately another thirty hours in a collidine (2–4–6 trimethyl pyridine)-lutidine (2–4 dimethyl pyridine) mixture (1 : 1 by volume) freshly equilibrated at the working temperature with the same volume of water. We then obtain a chromatogram (see accompanying illustration) which shows within a square of paper approximately 35 cm. by 45 cm. about twenty-four well-defined spots giving typical ninhydrin reactions. In addition there are at least three as yet unidentified constituents which appear yellow on the paper. By this means, positive and, we believe, unequivocable identification has been achieved of twenty-one amino-acids as normal constituents of the alcohol-soluble nitrogen of potato tuber tissue and three more still await final identification. So far as we are aware, this is the first systematic application of this relatively new technique to plant material, and some of the amino-acids thus identified will be reported for the first time to be present free in potato tissue and in plants.

A list of amino-acids (in the approximate order in which they are spread on the paper) which we have positively identified in the cold alcohol extract is as follows: cystine, aspartic and glutamic acids, serine, glycine, asparagine, threonine, alanine, glutamine, α-amino-*n*-butyric acid, histidine, arginine, lysine, methionine sulphoxide, proline, valine, methionine, isoleucine, phenylalanine, tryptophane and tryosine. Amino-acids which are still subject to investigation and confirmation or which are present in minimal amounts are: β-alanine or citrulline, and two distinct amino-acids near the position occupied by proline on the paper. The two latter substances have been seen by one of us (C. E. D.) in animal material and, therefore, they seem to be of general distribution in Nature. The possible presence of ornithine is still under investigation as there is some



A *B*

A. Two-dimensional paper chromatogram of alcoholic extract of potato tissue applied within the circle shown: direction of movement in phenol shown horizontally, movement in collidine-lutidine vertically. For the purpose of this photograph 150 μgm. of nitrogen were used: this larger amount reveals the relatively weak spots, although it tends to cause overlapping of some of the stronger ones. Using still larger amounts has revealed two constituents not shown here. Before photographing the original chromatogram each distinct spot was ringed with pencil. The photograph does not give a true rendering of the relative intensities of the spots, since it was necessary to 'print-in' certain areas to increase their density. *B* is a key to *A* prepared from a tracing from the original, but also showing the location of methionine and cystine as they are revealed after the extract is treated with H_2O_2. The identified substances are: 1, cysteic acid from cystine; 2, aspartic acid; 3, glutamic acid; 4, serine; 5, glycine; 6, asparagine, which gives a brown ninhydrin reaction; 7, threonine; 8, alanine; 9, glutamine; 10, α-amino-*n*-butyric acid; 11, histidine; 12, lysine; 13, arginine; 14, methionine sulphoxide; 15, proline which, owing to yellow ninhydrin reaction, does not show well in the photograph; 16, valine; 17, methionine sulphone from methionine which when unoxidized is normally obscured by the leucines at position 18; 18, isoleucine (leucine also occupies this position, but an independent method shows the predominance in these extracts of isoleucine); 19, phenylalanine; 20, tryptophane; 21, tyrosine. The as yet unidentified substances are: 22, probably β-alanine, although the position is also occupied by citrulline; 23, an unidentified amino-acid occurring in quantity; 24, an unidentified amino-acid occurring in small amounts; 25, 26, and 27 are unidentified substances of entirely unknown nature which appear as yellow areas on the chromatogram. These interesting substances are generally distributed in Nature, for example, large quantities have been found in normal blood and urine. The substance at position 25 characteristically distorts the spot due to aspartic acid at position 2.

difficulty in detecting it in presence of lysine. We do not claim to have exhausted the possibilities inherent in the method, but we do suggest that these are scarcely evident from the earlier statement by LaCour and Drew.

The mere list of amino-acids, coupled with our semi-quantitative observations, presents at the outset some interesting features. The preponderance of isoleucine over leucine (which we have not yet found) is surprising. Cystine and methionine require special procedure to demonstrate their presence[4] and although they have both been clearly seen they are by no means as conspicuous in the chromatograms as might have been expected. Hydroxyproline has not yet been positively detected. Glutathione can be revealed by the method but has not been seen in the chromatograms. α-Amino-*n*-butyric acid is present only in traces, and in accordance with the previous claim for its presence in blood and urine[6] it is suggested that it is more likely to be a breakdown product of an amino-acid (such as methionine) than an intermediary of protein synthesis.

Under conditions in which protein synthesis is known to occur in potato disks we have been able to show that many of these amino-acids decrease in amount to such an extent as to be no longer detectable in the chromatograms. Others, however, persist throughout in relatively large amounts, for example, glutamine and asparagine, glutamic and aspartic acids, and this is particularly suggestive in relation to the view[1] that in protein synthesis the soluble nitrogen may be drawn from a variety of stored amino-acids but is canalized through the system glutamine $\rightleftharpoons$ glutamic acid en route to protein.

We believe that the technique, in the form in which we have used it, opens a new chapter in the study of nitrogen metabolism in plants. However, the method will only be profitable if it is used in ways which utilize its remarkable selectivity. If the identity of a particular amino-acid cannot be established critically by matching against standards consisting of known amino-acids and by such specific tests as may be carried out either on the paper or on the amino-acid extracted from the chromatogram, the method of Polson, Mosley and Wyckoff[11], using electron defraction, offers other means of approach. It should also be noted that these authors claim to have used the paper chromatogram technique in a more quantitative manner after extracting the product of the ninhydrin reaction in acetone for subsequent measurement in a colorimeter.

Our own experiments will be reported in detail elsewhere, but it is already evident that the method enables one to detect the presence of a large number of amino-acids in plant cells and to reveal both qualitatively and quantitatively the changes which occur when cells, like those of the potato, embark upon protein synthesis and upon the kind of metabolism which normally culminates in cell division. It is true that the alcohol extracts do not localize the amino-acids in any particular cellular inclusion, and it will be necessary to find other means to demonstrate their distribution within the cell.

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ARMY EDUCATION COURSES: PREPARATION FOR MARRIAGE

In response to the great interest in family problems shown by students at the Command School, the General Officer Commanding, London District, sought leave to hold courses in "Preparation for Marriage" for Army personnel. Permission to hold such courses was granted by the War Office on condition that they should be looked upon as experimental and that attendance should be purely voluntary. Three such courses were held at the Command School, London District, during the summer this year, each of three days duration. The lecturing staff was provided by the National Marriage Guidance Council. In all cases the students were of mixed sex: at one of the courses men and women of all ranks attended together; for the others, officers and other ranks were divided into separate groups. The syllabus was planned to cover the sociology of marriage and the family, biology of sex and reproduction, sexual psychology and ethics, marriage and its adjustments, the emotional development of the child and the adolescent, parentcraft and homecraft. The speakers were Dr. D. Mace, Dr. Edward Griffiths, Dr. Gilbert Russell, Dr. Ethel Dukes, Mrs. Marjorie Hume and Mrs. Vera Mace. A special feature of each of the courses was a 'brains trust' consisting of all the speakers, who dealt at considerable length with each question. The questions themselves reflected a high level of frank and sincere inquiry.

In his report on these courses the General Officer Commanding, London District, is of the opinion that they were a distinct success. There was much evidence, he states, that they were appreciated by the students, who took the subject-matter as being long overdue, welcome and ordinary. As a result of this experiment, he recommends that further courses should be held in the London District, and that the holding of similar ones in other parts of the country should be considered. He also expresses himself as being in favour of permitting certain non-Service people to attend such courses, so that engaged and newly married couples might jointly take part in them. Special courses, he considers, should be held for married families in the Regular Army; and for the Roman Catholics separate arrangements should be made. It was generally agreed that the time allotted to these courses should be extended from three to four days.

It is stated that the Archbishop of Canterbury and the former Secretary of State for War regard these experimental courses as important preliminaries to Army-wide consideration of this vital subject. There would seem to be every justification for holding further ones and for widening their scope. These first courses were attended by carefully selected students who were engaged to be married, married, or sincerely interested; their ages tended to be higher than that of average Service personnel. Even so, there must be large numbers of similar men and women in the Services who would be glad to avail themselves of such valuable information and advice. Yet to restrict these courses on preparation for marriage to such students alone would be severely to limit the usefulness of what promises to become a most valuable branch of the educational service. For it is well known that in all the Services interest in sex and in personal relationships associated with sex runs at a very high level, while the temptations of physical gratification in surroundings away from home-circles are strongly intensified. The high incidence of venereal disease among members of the Forces is further evidence, not only of a medical and moral problem of serious dimensions, but also of the urgent need for a widely extended educational and advisory service which would have as its object the fostering of happy and harmonious family life.

To provide speakers with suitable training and outlook for such a service would at first throw a serious strain upon the National Marriage Guidance Council as well as upon the other voluntary organisations who are interested in sexual problems and family life. After a time, however, it should be possible for the Services to develop their own special educational and advisory staff. The preliminary courses also revealed a great need for a good supply of the right kind of books.

R. WEATHERALL

PHYSICS AND THE STEEL INDUSTRY

NEW LABORATORIES OF THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

THE laboratories of the Physics Department of the British Iron and Steel Research Association were officially opened by Lord Rayleigh on October 22. They are at 140 Battersea Park Road, London, under the charge of Mr. M. W. Thring, with a scientific staff numbering between forty and fifty. This is the second laboratory to be opened by the Association since its formation in 1945, the South Wales establishment having been opened on July 3 (see *Nature*, July 19, p. 100). The purpose of these laboratories is to enable the Association to carry out its function of supplementing and 'backing up' the great volume of research carried on by individual firms within the iron and steel industry. Before the formation of the Association, Corrosion Laboratories at Birmingham and the Marine Biology Laboratories at Millport (Scotland) were already in existence; experimental open hearth and blast furnaces have been constructed by the Association at Stoke-on-Trent, and plans are well advanced for the establishment of a metal-flow research station at Sheffield, which will complete the Association's immediate plans for the establishment of its own research stations.

Mr. G. H. Latham, president of the Association, presided at the informal lunch which marked the opening of the Physics Laboratories, when Lord Rayleigh spoke of the opportunities for physicists in the metallurgical field. Lord Rayleigh recalled discussions with Prof. Max Planck, Prof. H. L. Callendar, Sir Charles Parsons and others on the subject, and commented on the possibilities before the physicist in connexion with pyrometry, continuous casting, heat-resistant alloys and other such subjects. He commented on the increased organisation behind modern research, and "the great contributions to science and technology" that such organisation could make possible. Research had become a career, as a gathering such as that one demonstrated, and it was with pride and pleasure that he declared the Physics Laboratories open.

Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, spoke briefly and wittily in wishing that the work of the staff

might be "exciting as well as fruitful and productive. . . . Your industry abounds with opportunity for the physicist", he said. "It was Isaac Newton himself who first posed the theoretical problem of elucidating the strength of materials—of explaining why the contiguous parts of a solid stick together, and that problem still gives people something to think about even to-day." He paid a warm tribute to Sir William Larke's zealous and selfless work for industrial research. "Although the Research Association is in itself youthful", he said, "the research spirit has for many years been alive in the iron and steel industry, and it must be gratifying to the pioneers to see the steady development of the central research organisation under the vigorous leadership of your council and your director, Sir Charles Goodeve."

Mr. D. A. Oliver, head of the research department of the B.S.A. group of companies, spoke on behalf of the Council of the Association. Emphasizing the close relations between fundamental physics and the steel industry, he instanced Dr. Schofield's work on the quick-immersion thermocouple, and work at the Association's laboratories on lead sulphide cells, aerodynamic flow through models, spectroscopy and X-ray crystallography. He laid great stress on the close relations between the Association, industry, the universities and other research organisations.

After lunch the guests proceeded to an inspection of the new laboratories. These are disposed on two floors of a factory building, and comprise some 14,000 sq. ft. of laboratory and office space. Their equipment includes a 50-kW. output high-frequency induction furnace, X-ray diffraction apparatus, a 3-in. aperture black-body furnace (designed and built at the laboratories) for use up to 1,700° C. for calibration of pyrometers, and a complement of laboratory and steelworks equipment.

The arrangement of the Physics Department is based on a plan approved by the governing council of the Association in 1946, which envisaged three main functions for the Department. These are: (1) to keep in touch with the advances of physical science with a view to possible application in the iron and steel industry; (2) to carry out research into the more fundamental physical problems connected with the work of the Association; (3) to carry out on behalf of the various divisions of the Association, research and development in fields of physics which are common to more than one division.

The Department may therefore be described as a 'horizontal' department in the Association's organisation, carrying out fundamental research to assist any or all of the six divisions under which the bulk of the work is organised. These six 'vertical' divisions correspond to the main divisions within the iron and steel industry, and are largely autonomous in operation. It is therefore an additional function of the 'horizontal' departments to assist in maintaining liaison between the divisions.

In implementing this programme two guiding principles have been adopted. (i) Experimental work should be backed up by theory wherever possible in order to avoid laborious testing of every combination of conditions ('long-shelf' research). (ii) The use of similarity theory can greatly enhance the value of a research laboratory by enabling it to test on a fundamental scale the key laws underlying complex industrial processes. This is particularly true in the iron and steel industry, where processes are too involved to permit the reduction of conditions to a form which can be solved by physical measurements of the required coefficients and mathematical solution of the corresponding differential equations.

These considerations have led to the division of the work of the Department into five broad categories, each organised under a section with a separate laboratory and office accommodation in the Department's laboratories. The sections are general physics, instruments, heat and thermodynamics, aerodynamics and mathematics. Guests inspecting the laboratories were able to see work in progress in each section, organised on the following lines.

General Physics Section. This is concerned with the state of the physical properties of steel and the metals used in steelmaking, and the interrelations between these properties. In order to avoid overlapping existing programmes, this field has been narrowed by the choice of bulk rather than surface properties, and by an emphasis in the direction of the properties of iron and steel above 1,200° C., that is, in a temperature range concerned rather with manufacture than with use. Work on continuous casting, in so far as it is concerned with experiments of heat transfer and plastic flow and with models of commercial processes, is being carried out by the General Physics Section, which in addition to its main laboratory has an X-ray laboratory and dark rooms.

Instruments Section. This is concerned with the large and increasing use of instruments in the steel industry. Recent developments in instrument design have raised new possibilities, and a part of the work of the Instrument Section is to bring together the instrument industry and the iron and steel industry in improving the supply and application of existing instruments. Its other main line of work is to develop new instruments, and work is proceeding in connexion with the measurement of the tension of wire in the process of drawing, a remote-reading electrical pressure meter for furnace pressures, and new developments in automatic temperature and radiation recording.

Heat and Thermodynamics Section. Problems of radiation, temperature measurement and heat transfer, which are of vital importance to the steel industry, are dealt with in this Section, which has a high-temperature laboratory in addition to its main laboratory. The Section is working on projects concerned with the development of methods for measuring the thermal properties of flames in furnaces, the exact assessment of the properties of radiation pyrometers and the development of a black-body furnace for their calibration, and the development of improved methods for surface temperature measurement.

Aerodynamics Section. This Section is concerned with all problems of flow, whether of gas in furnace systems or of liquids such as molten steel, slag and iron, and granulated solids. Such work is largely carried out by means of models, such as those used to investigate the flow of gases in an open-hearth furnace or the action of air-jets on the steel in a side-blown converter. The first problem in such cases is to determine which physical properties govern the process, and hence what is the correct similarity criterion which governs the time-scale of the model after the dimensional scale has been fixed by considerations of convenience.

Mathematics Section. A Section to deal with mathematical investigations has been introduced to ensure that problems which are examined experi-

mentally will be dealt with also in terms of theory. It has already been found that more projects are coming along for calculation than can be dealt with by the number of staff originally planned. Among such problems are the heat transfer in continuous casting, the effect of oxygen on the thermodynamics of the blast furnace, the statics of furnace roofs when made with basic bricks, heat transfer in immersion pyrometers and in furnace systems, and the thermodynamics of the Bessemer converter.

There is also provision at the Physics Department's laboratories for a laboratory for the Association's Chemistry Department, and one for the Steelmaking Division. The former is devoted to investigations into the fundamental thermodynamic and kinetic aspects of the behaviour of iron and other elements during the process of iron and steel making. Dr. F. D. Richardson is in charge of this Department. The Steelmaking Division (under Dr. A. H. Leckie) carries out at Battersea work connected with instruments and process chemistry. In this connexion guests at the opening were able to inspect a mobile laboratory for use in steel works, which, mounted on an ex-army lorry chassis, has been designed by the Steel-making Division and assembled at the Physics Laboratories.

MARKET RESEARCH

THE importance to the manufacturer of acquiring accurate knowledge of his market is now becoming generally recognized. Should there have been any residual doubts, they were rapidly dispelled at the conference on market research conducted by the Manchester Joint Research Council on October 22, when the following papers were presented: "The Technique and Applications of Market Research", by Mr. O. W. Roskill (senior partner, O. W. Roskill, Industrial Consultants), "The Investigation of Trends of Consumer Tastes", by Mr. L. R. England (chief research officer, "Mass Observation"), and "Market Research and the Seller", by Mr. D. S. F. Vernon (Calico Printers' Association, Ltd.).

Mr. Vernon directed attention to influences such as machine production and increased mobility which were at work in the nineteenth century and which had the result of separating the producer from the consumer: "It is to bridge the gap between producer and consumer and appreciate more clearly 'consumer preference' (consumer requirements) that a scientific study of these factors has come to the fore under the label of Market Research". The other speakers noted the remarkable lack of knowledge of their own markets which was displayed by many manufacturers, even the efficient ones; and interesting examples were given by Mr. England and the other speakers of astonishing misconceptions as to the strength (or weakness) of customers' preference for a particular product.

In describing the technique of market surveys, Mr. Roskill observed four main avenues of investigation calculated to facilitate the establishment of the manufacturer's sales plan: the division of consumption into the separate uses for the goods in question, a survey of the factors affecting demand, an analysis of the channels of distribution and a knowledge of competition.

As might well be expected from a conference taking place in Lancashire, the treatment of the subject of market research was by no means confined to its relationship with consumable goods. In particular Mr. Vernon was concerned with the importance of investigations of textile markets, where the product is not one which is packed at the factory ready for final consumption, but a fabric which may be used for a variety of purposes. Similarly, Mr. Roskill devoted considerable attention to the technique of market research in relation to producer goods, and it is refreshing to note his emphasis upon the marketing problems which confront those manufacturers who are not concerned with the final retail consumer, but as sellers of semi-finished material, machine tools and other forms of industrial equipment are involved as links in a long chain of manufacture. In consequence, any analysis of the factors affecting the demand for their products cannot be limited to one immediate customer, but may involve an investigation extending into industries one, two, or even three times removed from the industry immediately under survey.

An aspect of market research which might perhaps have been elaborated with profit is the extent to which the manufacturer, having been presented with an analysis of his market, could venture to mould the demand to correspond with his manufacturing conditions. In so far as the market survey discloses the reasons for the preferences of customers, it should be possible to make some estimate of the risks involved in persuading them to accept articles which do not entirely conform to their tastes and prejudices, but which present advantages from the manufacturing point of view. The problem is one which is exercising the minds of manufacturers to-day, particularly those concerned with export markets, and invaluable guidance would be given to them if it were possible to assess the probable reactions of foreign customers, for example, to a policy of greater standardization directed towards the reduction of manufacturing costs by increasing the length of runs on relatively few models.

PROBLEMS OF SOIL AND LAND CLASSIFICATION

THE newly formed British Society of Soil Science held its first conference during September 26–29 in Oxford; the principal topic of discussion centred on problems of soil and land classification.

The first session was devoted to the problems of soil classification, which fall into two categories: how far can soils, which show continuous gradations from one type to another, be divided into types with sufficiently sharply defined differences, so that a soil map can be made of a whole region; and whether the soil map should be made without any reference to the use to which it will be put. Mr. C. G. T. Morison (Oxford), Prof. G. W. Robinson (Bangor) and Prof. S. W. Wooldridge (London) read papers at this session and many members took part in the discussion.

The first two speakers were concerned with mapping soils by 'associations'. In any one region the soil will vary because, as Prof. Robinson put it, the soil is a passive agent of variable constitution acted upon by climate, vegetation and so forth, and these vary over the region. In many regions most of these active agents remain fairly constant with only one or two changing appreciably. Such an area can then

be mapped, not by mapping the individual patches of the different kinds of soils present, patch by patch, but by indicating that all variations occur in regular succession between certain types. This includes both the ordinary method of mapping associations and Milne's method of recognizing catenas. The principle is easily applied if only one soil-forming factor is varying appreciably over the region, but becomes more difficult to apply if several are varying. Prof. Wooldridge discussed the more specific problem of the value of recognizing the geomorphological age of the surface on which the soil is formed, and illustrated the points he made by discussing the chalk surfaces of southern England.

The second session was devoted to problems of land classification. Here the problems are of immediate interest to the community, since they concern the conflicting demands upon the use of land for buildings, mineral exploitation and food production. Dr. E. C. Willatts described some of the problems confronting the administrator who has to approve certain types of land use, developments and changes to ensure they are consistent with the policy laid down in the White Paper on "The Control of Land Use" (Cmd. 6537) and in subsequent legislation. By clearly stating the problems facing land planners, he hoped that soil surveyors and other people who had to assess the value of land would prepare their results in such a form that the administrator could easily understand and use them.

Dr. D. A. Osmond gave the definitions, adopted by the West Midland Group on Post-War Reconstruction and Planning, for classifying agricultural land into three categories of good, medium and poor on the basis of its inherent features of site and soil. Site involves the consideration of aspect, slope and elevation, while water-conditions, depth and texture are taken into account as soil factors. Using this simple classification, the major categories of agricultural land can be readily picked out. Eight western counties of England have been mapped on this basis. Because of the high farming on soils frequently of medium quality, market garden areas such as the Vale of Evesham, and some other districts, are included in sub-categories of good agricultural land.

Mr. F. R. Day (Oxford) then discussed criteria for judging the economic value of land for forestry. He showed that if the tree is to come to a proper height at maturity, or at a given age, there is an optimum curve relating its rate of growth with age for each species of tree in a region. Any falling off from this curve is due to some soil factor making the site less suited for the economic exploitation of that species. He illustrated these points by discussing the rate of growth of forest on thin or wet land, often considered suitable for forestry because unsuitable for agriculture, and showed that growth of many species is too slow for economic exploitation, even though initially the growth may be very rapid.

Finally, Mr. G. R. Clarke (Oxford) described the gravel survey of the London area, a survey undertaken to map the good, medium and indifferent agricultural soils overlying the gravel. The object was to see how far it would be possible to prevent the exploitation of the gravels under the best agricultural and market garden land and to continue their exploitation under the poorer soils. Unfortunately, as Prof. Wooldridge later pointed out, there are many different types of gravels, and some essential for making concrete only occur in sufficient quantity under some of the best agricultural land.

TUBERCULOSIS OF VOLES AND SHREWS

IT is ten years since Dr. A. Q. Wells reported the presence in the wild vole (*Microtus agrestis*) of a murine type of tubercle bacillus; since then a good deal of work has been done upon this organism. Tuberculosis has been found also in the bank vole (*Clethrionomys glareolus*), the wood mouse (*Apodemus sylvaticus*) and the shrew (*Sorex araneus*), and the relationships of this murine type of tubercle bacillus to the bacilli which cause human and avian tuberculosis have been carefully studied. The present position of our knowledge of the problems raised by the discovery of this bacillus has now been ably stated by Dr. A. Q. Wells in a report entitled "The Murine Type of Tubercle Bacillus (The Vole Acid-Fast Bacillus)", to which Dr. A. H. T. Robb-Smith has contributed notes on the morphology of infection by the vole acid-fast bacillus.*

Illustrated by very clear photographs and by graphs and diagrams, this report is a valuable addition to the literature about tuberculosis. The structure, cultivation, antigenic structure, pathogenicity and other features of the vole bacillus are all discussed, and Wells concludes that the statement that the disease which it produces is tuberculosis "seems justified, in spite of the fact that tuberculosis as a disease of other wild animals in their natural habitat has not hitherto been found". It is not possible to separate the vole bacillus from the human or bovine bacilli tubercle by serological methods; animals infected with the vole bacillus are sensitive to human or bovine tuberculin, and animals infected with human or bovine tubercle bacilli are sensitive to a tuberculin prepared from the vole bacillus. The vole bacillus can, moreover, produce progressive disease of the animals which it can infect, and this disease is indistinguishable from that produced by human or bovine tubercle bacilli. The vole bacillus is therefore a third type of tubercle bacillus. One of the most valuable sections of this report discusses experiments which have been designed to find out whether experimental infection of laboratory animals with the vole bacillus will confer any degree of immunity to the human or bovine tubercle bacilli. The use of a vaccine prepared from the vole bacillus for the production of immunity in man is also described; and the instrument used for some of these experiments, which enables forty simultaneous punctures of the skin to be made, is described and illustrated. Wells discusses the results obtained and also the relative merits of B.C.G. vaccine and the vole bacillus vaccine. An evaluation of the results obtained can be made only by experts who have a wide experience of that kind of work. Those who are interested must read the report itself.

Dr. A. H. T. Robb-Smith's notes on the lesions produced by the vole bacillus and the excellent photographs of them with which he illustrates his notes are a worthy addition to the report. Everyone who is interested in the intricate problems presented by tuberculosis will be grateful for the inclusion in a single compact and well-written publication of so much information, together with the references to the literature which are relevant to it.

G. LAPAGE

* Medical Research Council. Special Report Series, No. 259. The Murine Type of Tubercle Bacillus (The Vole Acid-Fast Bacillus) with Notes on the Morphology of Infection by the Vole Acid-Fast Bacillus. By A. H. T. Robb-Smith. Pp. iv+48+13 plates. (London: H.M. Stationery Office, 1946.) 2s. net.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 17

ROYAL PHYSICAL SOCIETY OF EDINBURGH (at the Royal Scottish Geographical Society, Synod Hall, Castle Terrace, Edinburgh), at 5.15 p.m.—Dr. D. O. Morgan: "The Liver Fluke".

Tuesday, November 18

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (at the London School of Hygiene and Tropical Medicine (Room 105), Keppel Street, London, W.C.1), at 1.10 p.m.—Mr. Elliott Jaques: "Methods of Changing Group Behaviour".

CHADWICK PUBLIC LECTURE (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. G. A. R. Sheppard: "Modern Trends in Waterworks Practice" (Bossom Gift Lecture).*

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. J. G. Malloch: "Scientific Research in Canada and its Links with Science in the United Kingdom" (Neil Matheson McWharrie Lecture).

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Physical Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. R. S. Cahn: "The Role of Chemistry in Recent Developments of Animal Insecticides".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Rev. E. W. Smith: "The Ba-Ila Revisited".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "The Vegetation of the Chalk", 4, "The Woodlands of the Chalk".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. G. C. L. Bertram: "Eugenics, Population Trends and the World's Resources".*

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (joint meeting with the CHEMICAL ENGINEERING GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. F. M. Schuftan: "A New Process for the Recovery of Ethylene from Coke-Oven Gas".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at St. Enoch Hotel, Glasgow), at 7 p.m.—Dr. A. Landolt: "Improvement of the Properties of Fibres and Dyeings by Treatment with Hydrophobic Melamine-Formaldehyde Compounds".

Wednesday, November 19

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Ernest T. Fisk: "The Development of Sound Recording and Reproduction".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Scientific Papers.

ROYAL MICROSCOPICAL SOCIETY (at B.M.A. House, Tavistock Square, London, W.C.1), at 5 p.m.—Communications on "Electron Microscope Studies of Tissues from High- and Low-Breast Cancer Strains of Mice" (to be introduced by Prof. R. D. Passey).

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Wellcome Research Institution, 183 Euston Road, London, N.W.1), at 6.30 p.m.—Annual General Meeting.

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (at the Victoria Station Hotel, Nottingham), at 7 p.m.—Dr. E. S. Paice: "Petroleum Chemistry as applied to Textiles".

Thursday, November 20

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Symposium on "The Results of the Heligoland Explosion" (to be opened by Dr. E. C. Bullard, F.R.S.); at 4.30 p.m.—Special General Meeting to consider the Annual Report of Council.

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, The University, Liverpool), at 4.30 p.m.—Prof. H. W. Melville, F.R.S.: "The Chemistry of Ethylenic Polymers".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—"Cross-Linking in Polymeric Systems" (other lectures on November 27, December 4 and 11).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Report on "The Practical Training of Professional Electrical Engineers" (to be presented by Sir Arthur Fleming).

CHEMICAL SOCIETY (joint meeting with the UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the University College, Hull), at 6 p.m.—Prof. A. C. Chibnall, F.R.S.: "The Structure of Proteins from the Viewpoint of the Chemist".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. W. Bosley: "The Cyclotron and Betatron".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, November 21

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. J. Greig and Mr. H. Kayser: "Iron-Loss Measurement by A. C. Bridge and Calorimeter".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Sir Alwyn Crow: "The Rocket as a Weapon of War in the British Forces" (Thomas Hawksley Lecture).

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. G. Taylor: Streatfeild Memorial Lecture.

SOCIETY OF DYERS AND COLOURISTS, MANCHESTER SECTION (joint meeting with the TEXTILE INSTITUTE, in the Gas Department Showrooms, Town Hall Extension, Manchester), at 7 p.m.—Mr. C. P. Tattersfield: "The Effect of Physical Pretreatment on the Ease of Saponification of Cellulose Acetate Rayons and Films".

CHEMICAL SOCIETY (in the Royal Technical College, Glasgow), at 7.15 p.m.—Prof. M. G. Evans, F.R.S.: "Electron Transfer Reactions".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. H. Desch, F.R.S.: "Recent Developments in the Steel Industry".

Saturday, November 22

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at Brighton Technical College, Brighton), at 6 p.m.—Mr. J. G. N. Gaskin: "The Examination of Questioned Documents".

Thursday, November 20—Friday, November 21

INSTITUTE OF PHYSICS (joint meeting of the MIDLAND GROUP and the X-RAY ANALYSIS GROUP, in the Temple Room, Imperial Hotel, Birmingham).—Conference on "The Structure and Physical Properties of Metals".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN CHEMISTRY up to B.Sc. standard—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (November 22).

PRINCIPAL DEPUTY DIRECTOR and a DEPUTY DIRECTOR (Research) in the Meteorological Office—The Under-Secretary of State, Air Ministry (S.2), Cornwall House, Waterloo Bridge Road, London, S.E.1 (November 30).

LECTURERS IN GENERAL SCIENCE, GEOGRAPHY, and MATHEMATICS—The Secretary, University of London Institute of Education, Malet Street, London, W.C.1 (November 30).

CHAIR OF GEOGRAPHY at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 1).

ASSISTANT DIRECTOR (Development) IN THE DEPARTMENT OF ATOMIC ENERGY, Risley, Lancs—The Ministry of Labour and National Service, Technical and Scientific Register, Room 699, York House, Kingsway, London, W.C.2, quoting F.898/47A (December 2).

CHAIR OF BOTANY at Queen Mary College, and the HILDRED CARLILE CHAIR OF BOTANY at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 4).

SUPERINTENDENT OF THE ENGINEERING DIVISION of the National Physical Laboratory in the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2034 (December 4).

FUEL ENGINEER to undertake the investigation of problems associated with the use of turf in domestic and industrial consumer appliances—The Secretary, Bord na Mona, 28–30 Upper Pembroke Street, Dublin (December 6).

EDUCATIONAL PSYCHOLOGIST—The Secretary, The University, Edmund Street, Birmingham 3 (December 6).

SENIOR PRINCIPAL SCIENTIFIC OFFICER in the ROYAL NAVAL SCIENTIFIC SERVICE (in the first instance as Superintendent of the Royal Naval Physiological Laboratory, Gosport)—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2025 (December 8).

PRINCIPAL SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS in the Ministry of Supply, (*a*) at Headquarters in London for handling research work connected with high temperature alloys and materials for use in gas turbines and other engines, (*b*) at the Royal Aircraft Establishment, Farnborough, to undertake research and development work on light alloys used in aircraft production—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2032 (December 9).

DEPUTY to the SCIENTIFIC ADVISER to the Army Council—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2026 (December 10).

CHEMIST IN THE ENDOCRINE UNIT—The House Governor, London Hospital, Whitechapel, London, E.1.

PHYSICIST or METALLURGIST with X-ray crystallographic experience, and a METALLURGIST, for research on the surfaces of metals and coatings—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

SENIOR LECTURER IN MATHEMATICS—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3.

LECTURER IN BACTERIOLOGY—The Registrar, The University, Reading.

MATHEMATICAL PHYSICIST for the Theoretical Physics Branch of the Research Division—The National Research Council, Atomic Energy Project, Chalk River, Ont., Canada, quoting File 9–F.

ORGANIC CHEMIST, a RADIO or ELECTRONIC ENGINEER, and a TECHNICAL ASSISTANT for general laboratory work—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

LECTURER IN PHARMACOLOGY—The Dean, College of the Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1.

RESEARCH ASSISTANT IN THE POMOLOGY DEPARTMENT—The Director, John Innes Horticultural Institution, Merton, London, S.W.19.

LECTURER IN PHYSICAL CHEMISTRY to Honours Degree standard—The Registrar, College of Technology, The Newarke, Leicester.

LECTURER IN MATHEMATICS—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C.3.

LECTURER IN PHYSIOLOGY—The Registrar, University College, Nottingham.